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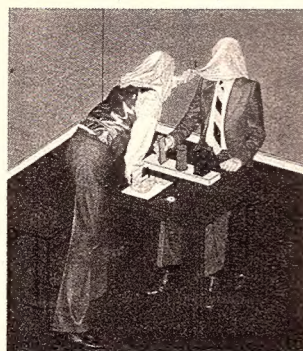
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Debate over genetics and intelligence is raging in Britain again, following the publication of a pamphlet on the subject by the National Union of Teachers. *New Scientist* asked the principal disputants to consider some of the central issues (see p 849).

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Comment

Towards UNCSTD

A mere five months are left in the countdown to the United Nations Conference on Science and Technology for Development. How is UNCSTD shaping up? Criticism from all sides mounts, making it clear that the conference's secretariat has done little about, for example, the inadequate participation of scientists and technologists in both rich and poor nations. The most recent preparatory meeting in New York proved to be a forum for general condemnation by the delegates of the flaccid draft programme of action—which embodies no action at all. Yet no one can deny that the programme is based in part on the national papers submitted by the participating countries and it is generally agreed that the quality of these papers varies widely. Moreover, despite widespread dissatisfaction with the programme, nobody at the New York meeting was willing or able to devise an alternative.

To be more positive, there are some constructive moves towards alternative programmes for action, in time for discussion at the next preparatory meeting in New York at the end of April. One example of what can be achieved was the outcome of the recent gathering in Singapore of non-governmental scientific organisations, including the International Council of Scientific Unions (see p 843). A short, five-page draft report summarises the modest action plan of the International Symposium on Science and Technology for Development, which calls for a continuing committee of scientists drawn from these organisations to decide on their own research priorities for the Third World.

Money to finance the work would come partly from a new Science and Technology Fund and partly from a consortium of donors, thus ensuring project continuity and independence. How politicians within the national governments of both rich and poor nations and certain factions of the UN agencies would welcome scientists sidestepping their authority remains to be seen, but we can expect that until the fund grows to an attractive size it is safe from interference. Despite these forebodings, this plan, devised by and for scientists, is a welcome alternative to the repeated platitudes we have heard so far about the need to create a New International Economic Order or a new "scientific infrastructure". *Stephanie Yanchinski*

Moon talk?

Ask for the Moon and you might receive a larger slice of green cheese seems to be the most reasonable rationale behind the National Union of Teachers' claim for a 36.5 per cent rise in pay, unveiled last week. The NUT's dominant position in the negotiations means that the smaller teaching unions have little choice but to follow suit and the NUT argument about comparability has a rare authority. Lord Houghton's report four years ago on the salaries of teachers outside the universities established the current meaning of the word.

Apart from the size of the claim (which would, if granted, do horrible things to the rates), a number of other considerations instantly arise to confuse the issue; an entangled chain of Darwinian evolution. The Houghton report established at a stroke a massive anomaly, reducing relatively speaking the salaries of university teachers compared with those in the public sector schools, colleges and polytechnics. This in its turn was linked with a Gilbertian relationship between senior research workers in the scientific civil service and university professors and readers. The university positions were used to define the

civil service responsibilities but the salary link was severed and the civil servants' salaries quickly shot ahead.

Meanwhile the Association of University Teachers plodded on and succeeded in achieving a rather miserable rectification, so-called, of the anomaly between themselves and other teachers, three years late and in a couple of almost imperceptible instalments. The university teachers were due for a salary increase last October, and actually received an anomaly increase, since when they have been waiting more or less patiently to see which way the teaching cat would jump. Yet another comparability study is under way, and a good each-way bet is that everyone will settle for about 9 per cent and part friends.

Provided, that is, if they forget the anomalies. Information is that the Department of Education and Science chimera is of second and third order anomalies with schoolteachers, polytechnic teachers, university teachers and the scientific civil service all circling round each other in a kind of anomalous *Walpurgisnacht*. The position is hardly helped by extreme governmental firmness on the subject of 5 per cent, coupled with equally extreme vagueness about the possibility of supplementary central support should the settlements significantly exceed that figure.

Beyond doubt, significant is that young scientists and engineers now see few prospects and small financial reward in academic life, and the briefly burnished image of British industrial life is once again becoming tarnished. If they decide to vote with their feet and go elsewhere, the loss of their skills could inflict more permanent damage on our community and its economy than a transient inflation ever could. *John Delin*

Wilderness versus industry

The conservation battle for the Alaskan wilderness (*New Scientist*, vol 80, p 424) is far from won, and conservationists will be unwise to relax their vigilance, because President Carter has invoked the Antiquities Act of 1906 to declare some 230 000 square kilometres of federal land as national monuments. Monument status certainly provides protection, but not the same high degree of protection as does designated wilderness, and only Congress has the power to make such designations. The fate of the further 225 000 square kilometres of public lands withdrawn pending designation by Congress of new conservation units, and barred to commercial development for three years, will be bitterly contested by the State government and the industrial lobby, using all the sophisticated and unscrupulous public relations tactics the latter can deploy so effectively in Washington.

It is fortunate that President Carter has taken such a courageous and imaginative stand. He has said that "The passage of an Alaska bill by the next Congress is the highest environmental priority of my administration. In Alaska we have a unique opportunity to balance the development of our vital resources with protection of our natural environment. We have the imagination and the will as a people both to develop our last great natural frontier and also to preserve its priceless beauty for our children and grandchildren."

We should be under no illusions, however. Senator Ted Stevens, other Alaskan senators, and their industrial masters are unlikely to take that lying down. Their interests call for maximum profits and exploitation as quickly as possible, and they have three years in which to try and put the skids under the president. *Bryan Sage*

This week

Government reviews organisation of British science

Lord Rothschild was almost right when he told the government to institute a customer/contractor relationship between itself and the research councils. This is the message that comes through in a review of the changes made five years ago, in the wake of Lord Rothschild's 1971 report, *A Framework for Government Research and Development*, and the subsequent 1972 White Paper of the same name (Command 5046). There are, however, some admissions that everything hasn't turned out perfectly. And one disaster has been the government's attempt to lure scientific civil servants into Whitehall. Scientists, it seems, just do not want to become administrators.

One lesson that the government has learned over the past five years is that there should be some stability in research funding. Shirley Williams, Secretary of State for Education and Science and the person responsible for most of the money that goes to the research councils, told *New Scientist* that she sees this as the major point made in the new White Paper (*Review of the Framework for Government Research and Development* (Cmnd. 5046), Command 7499, HMSO, £1.25).

When the customer/contractor principle was adopted the idea was to give the government's departments more control over the research councils' R&D. The goal was to make that R&D more relevant to social needs and less at the whim of the research community. To achieve this some of the money that was paid directly to the councils was handed over to government departments so that they could spend the money on commissioned research carried out by the councils.

With their money coming from the government through intermediaries, rather than directly from the Department of Education and Science, the RCs,

Michael Kenward

as contractors, have been vulnerable to budgetary fluctuations as the ministries have shifted their funds around in the light of recent government spending constraints. The review says: "For these contractors some certainty of funding is essential." It adds that "in each case Departments are now endeavouring to provide an orderly succession of commissions, with the financial support planned well in advance, and, when changes in commissioning are inevitable, to give reasonable notice to the contractor."

Another problem that has resulted from the introduction of the customer/contractor principle is the loss of some RCs' freedom to pursue ideas for which there is no immediate customer. This, of

course, probably includes much of the speculative work that is at too early a stage for the researchers to be able to put forward a convincing case for support to their government paymasters. This problem is especially severe for the Agricultural Research Council, which receives over half of its funds as commissions from the Ministry of Agriculture, Fisheries and Food and as a consequence some 80 per cent of the ARC's scientists spend at least part of their time on work that has been contracted to the research council. This has made it harder to redeploy staff for new research.

The Medical Research Council has had to cope with a sponsoring ministry, the Department of Health and Social

Continued on next page

Scientists take action on development

The International Council of Scientific Unions (ICSU) has, with other international, non-governmental, scientific organisations, devised an action programme which proposes new, direct links between scientists and technologists in rich and poor nations. A Science and Technology for Development Fund, proposed by the plan, would pay for research jointly worked out by scientists drawn from organisations such as the Union of International Engineering Organisations, the International Council for Philosophy and Humanistic Studies, and the International Union for Conservation of Nature and Natural Resources, as well as ICSU.

The plan is one of the recommendations contained in the five-page draft report of a recent meeting in Singapore—the International Symposium on Science and Technology for Development (ISSTD). The plan suggests turning the symposium's steering group into a permanent committee, charged with identifying "global" areas where scientific knowledge and technological innovation are lacking. The continuing committee would also be responsible for launching Programme Identification Missions to spell out in detail the "principal scientific questions", the approach, the programme, the criteria for selecting the implementing institutions and the schedule.

The committee would also have to find the finance for the research, from a "consortium of donors", which includes the UN agencies, national aid bodies and even multi-national corporations. The ISSTD group envisages financial arrangements along the lines of the autonomous or semi-autonomous Canadian International Development Research Corporation (IDRC) or the Swedish SAREC. But the report recommends that to be truly independent a special core fund should be established—the Science and Technology for Development Fund—supplemented by special sources for each particular project.

As evaluation of the success of these projects is vital, the report recommends that ISSTD be reorganised to become a small permanent body of experts meeting every three years to assess work in hand. If the plan gets underway, the first such meeting would be held in 1982.

The first project missions are already clearly identified by the group and revolve around the problem of providing for the basic needs of the Third World—adequate food and shelter—rather than esoteric Western science. They include: forestry management, tropical architecture and human settlements; nutrition and human health; fish farming; rural energy supplies and water resources. The first priority area established at the Singapore meeting is development of rural industries, based on agricultural products "so as to focus attention on the rural areas and because technology absorption and a wide range of scientific and technological problems are involved".

But what is the likely reaction of the UN and national governments to these proposals to enable scientists to take action on their own? In his address to the ISSTD at Singapore, Professor F. Mayor, deputy director general of UNESCO, seemed to be in favour, in principle. He said: "UNESCO is very conscious of the need for the international thinking of the world's scientific community to be voiced, in its own right and for its opinions to form part of the discussions at UNCSTD and in the follow-up." He suggested that, "what seems to be needed is an additional mechanism linking the UN system with the scientific and technological non-governmental organisations *per se*." He was in favour of a separate fund, drawing contributions from many sources. "This money would support many projects which because of lack of financial support could not have been implemented and permit such projects to be carried out by a variety of different partners," encouraging a flexibility of approach not often evident in UN-sponsored projects. □



"The Ministry wants us to develop a viable scientific civil servant"

Thisweek

continued

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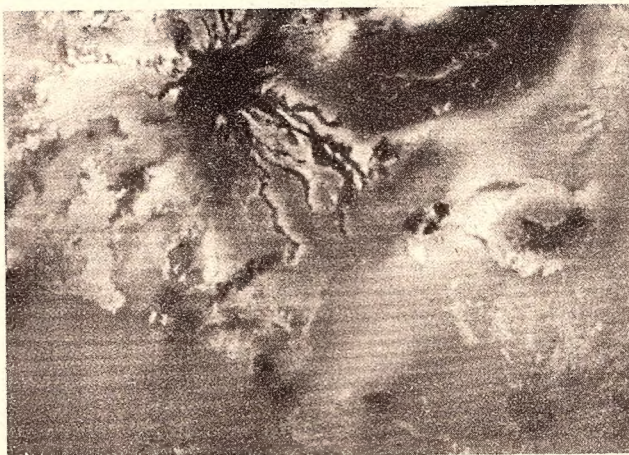
Security, which has had little idea of what research can do for it. This has had its advantages—the MRC has had to educate the DHSS in the ways of research and in the process it has been able to defend its existing programme more vigorously than other RCs. On the other hand, the MRC and DHSS still have not worked out how to live with one another, even though the changes were made some five years ago. The White Paper says: "In the light of experience new administrative arrangements have now been instituted in the Health Departments to indicate to the council the range of health topics to which they would wish to see biomedical research applied."

The White Paper also looks at the role of scientists in government. The earlier reports wanted to encourage more scientists to acquire administrative skills, partly to enrich government administration and partly to improve the management of science. The mechanisms established to encourage scientists to make the transition from the scientific civil service into the administrative civil service have not worked.

One scheme, set up in 1972—the Senior Professional Administrative Trainee Scheme (SPATS)—has been a miserable failure. In 1972 24 scientists took part in SPATS training, but in 1978 the intake had fallen to four people. Other schemes have been equally disappointing in their impact. The White Paper concludes: "Some evidence now suggests that the personal priorities of scientists may be different from those of administrators . . ."

Partly to understand this phenomenon and partly to deal with complaints of the civil service scientists' own career structure, the White Paper announces a "wide-ranging and radical review of the recruitment, structure and management of the Scientific Civil service to see that we have the staff of the quality and experience needed to undertake the full range of work expected of scientists now and in the future". The study will be carried out by a small working group under the chairmanship of Dr Martin Holdgate, Director General of Research for the Environment and Transport Departments.

This is one of four areas in which the White Paper presages action. The paper also says there will be a review of the new arrangement recently created to bring the DHSS and MRC into harmony. It also says: "Government Departments will examine with the [Social Science Research Council] arrangements for commissioning social science research with a view to establishing a satisfactory *modus operandi*." Finally, the government says that it has invited the Advisory Board for the Research Councils—hitherto the talking shop where the research councils fought for their shares of the science budget—to "devote more time to the consideration of general scientific issues". □



A volcanic crater, 170 km across, on Io, one of Jupiter's moons. The dark striations are probably basaltic lava flows, typically 100 km long and 15 km wide

Voyager spots volcano on Jupiter's moon

As Voyager 1 speeds on its lonely journey to Saturn, scientists at NASA's Jet Propulsion Laboratory in Pasadena, California, continue to study the amazing pictures of the Jovian system that the spacecraft has returned to Earth.

Photographs stored in Voyager's tape recorder and sent back on Wednesday, 7 March have revealed a large volcano on Io, the innermost of Jupiter's four major moons. The lack of meteorite craters on the slopes of the volcano, which is similar to those on the island of Hawaii, indicate that it is relatively young. So Io, a rocky body about the same size as Earth's moon, probably has an active, molten interior, like that of

the Earth. S. Peale of the University of California, and colleagues at the NASA's Ames Research Center in California recently suggested that the dissipation of energy from tides induced on Io by Jupiter might indeed produce a runaway melting process, resulting in a molten core (*Science*, 2 March, p 892).

The volcanic nature of Io provides an explanation for other surprising features such as the smooth surface. Prior to the Voyager mission, scientists had expected the surface to be deeply cratered like that on the Moon. Instead, Io is probably covered with a smoothing layer of volcanic salts, which also give it its dark red and yellow appearance. □

Press freedom threatened by H-bomb

A US judge has temporarily banned a political magazine from publishing an article which, according to the federal government, revealed "secret restricted data" about the hydrogen bomb. The case could turn into a major constitutional battle between national defence interests and the freedom of the press.

District Court Judge Robert Warren issued a temporary restraining order against *The Progressive*—an old, established radical monthly based in Madison, Wisconsin—after government lawyers argued that the article contained information about the design of thermonuclear weapons which, if published, would endanger national security and damage international efforts to prevent nuclear proliferation. The government's request for a permanent injunction to stop the magazine ever publishing the article is due for a court hearing on Friday.

The Progressive claims that the government was violating the First Amendment of the US Constitution, which forbids prior restraint of publication. Its lawyers also maintain that the article's author, freelance writer Howard Morland, had used no classified document and had based his story on interviews, scientific and technical literature and guided tours of nuclear facilities.

The case is thought to be the first government attempt to prevent publica-

tion of a newspaper or magazine story since the Nixon administration lost its celebrated Pentagon Papers suit in 1971. In the preliminary hearing before Judge Warren, the government lawyers argued successfully that *The Progressive* case differs from the Pentagon Papers because this time they are relying on specific law, the Atomic Energy Act, which prohibits the communication of restricted information about nuclear weapons. The Supreme Court ruled that no specific law entitles the administration to suppress publication of the Pentagon Papers.

The government became aware of Morland's article in time to suppress it because the magazine itself sent a copy to the Department of Energy at the end of February, asking for verification of its "technical accuracy". The manuscript was entitled *How a hydrogen bomb works* and according to the government's evidence to Judge Warren, it started: "What you are about to learn is a secret, a secret that the United States and four other governments have gone to extraordinary efforts to protect."

The article reportedly contains several detailed diagrams of H-bombs. Affidavits by government nuclear experts claimed that it might enable certain foreign governments to produce thermonuclear weapons in a few years rather than decades. □

Select committee questions GMAG's membership

The Department of Education and Science (DES) explained its policy on genetic engineering to the House of Commons Select Committee on Science and Technology again last week. This time it was the Secretary of State, Shirley Williams, who was giving evidence. Her performance produced fewer sparks than that of her civil servants some weeks earlier (*New Scientist*, 15 February, p 459).

Once again the MPs concentrated on the issues of secrecy and the membership of the Genetic Manipulation Advisory Group (GMAG). It is clear that the Institute of Biology, to name just one learned organisation, is unhappy about being ignored when the members were chosen for GMAG and has been lobbying members of the select committee. The MPs asked Shirley Williams how she decided who to appoint to GMAG, and whence came the nominations for members. Ted Leadbitter, MP, told the Science Secretary that Queen Mary College has objected to the way in which GMAG's members are recruited because they are selected by civil servants. To this Mrs Williams replied that it would be "contemptible" if ministers listened only to civil servants. However, she

doesn't want GMAG to be "institutionalised", with members being nominated by groups with special interests in the subject. She prefers people to be chosen "for what they have personally done". Not only would people nominated by groups have to represent vested interests rather than the best scientific knowledge, but also any committee assembled in this way is likely to consist of very senior people who have long since ceased to be active in their areas of science. That, says Mrs Williams, is not a good idea for a new science that is only a few years old. We can't have the researchers judging their own activities, Mrs Williams told the MPs. So the problem is to find people who know something about the subject but are not working in the field themselves.

Mrs Williams stressed that the members of GMAG were chosen "after very full consultation" and this included the learned societies. Well, maybe that isn't quite the case, she was told by one of her assistant secretaries; according to J. V. Cowen, the DES consulted the research councils rather than the learned societies when it set up GMAG; and he had to admit that he doesn't really know where the RCs turned for their advice,

a point that the MPs failed to follow up.

On the issue of secrecy, MPs expressed concern about the number of experts who withdraw from GMAG's deliberations when particular projects come up for discussion. They do this because, as is the case for the Trades Union Congress's representative, Ron Owen, they want to be free to pass on anything they learn at GMAG to the people they are supposed to represent; or they do not want to be involved in issues of commercial security because they have industrial interests themselves. Ken Warren, MP, told the Science Secretary that, from his point of view, this can leave the committee rather expertless at times.

On another aspect of secrecy, national security, Mrs Williams told the MPs that to the best of her knowledge no work is being carried out by or for the Ministry of Defence. The MOD has not, as it would be obliged to under the law, sought an exemption from the safety regulations which call for all genetic engineering research to be vetted by GMAG.

The Science Secretary foresees a rapid increase in the number of projects that GMAG has to advise on. And while no research is being delayed this explosion in genetic engineering could be held up by a shortage in adequate laboratory facilities, said Mrs Williams. She told MPs that it might cost around £40 million to bring all university laboratories into line with the safety requirements of the Health and Safety Executive—this could cover improvements far beyond those needed for genetic engineering—and so far only £2 million has been made available. □

What's bugging the European Patent Office?

Can a microorganism be patented? If so does it represent an exclusion from the European Patent Office's (and Britain's) present ruling that no patent can be taken out on a plant or an animal? Does the answer to this question depend on interpretation of EPO's "Rule 28", governing conditions under which new biological creations are maintained, and if so, who can you believe? Or will Rule 28 be changed as is rumoured? And how many products or processes are worth patenting anyway?

All these questions, and others ranging from the fascinating to the baffling, were put at Europe's first ever conference in London on "patents in genetic engineering, microorganisms and plants". The audience of patent agents, microbiologists and legal experts were, in a manner of speaking, making history.

But if the subject seems to be out of touch with reality, two aspects discussed at last Wednesday's meeting are deadly serious. First, two applications to patent microbiological inventions in the US are about to gain either support—and therefore a future—from a US Court of Customs and Patent Appeals in Washington or to be dismissed. Secondly two existing patents on genetic engineering processes (one each in the UK and US) could, if they survive legal tests of their present wording by competitors, give their holders control of future processes.

Ananda Chakrabarty of General Electric has a bug capable of metabolising crude oil. Patent experts believe that not only is this bug patentable (it is not only new but exhibits "utility") but the

process by which it is created should be also. The other is more perhaps crucial to future genetic engineering. Malcolm Bergy of Upjohn and Co admits that the microorganism that is essential to his invention—which is of a biologically pure culture of it—is not novel; he found it in a soil sample taken from the southwest US. But the drug he can produce (a type of streptomycin) is both novel and useful, and meets another primary patent requirement of being "non-obvious". But the question before the US court is whether the culture meets the criterion of "invention".

In Europe there appears to be confusion over how to interpret the rulings of the EPO, a body which only came into existence last June. Volker Vossius, a German patent agent who has fought previous test cases in his country, believes that the EPO will accept microorganisms as patentable. Bernard Budd, QC, who has experience of attempts to patent biological processes in the UK believes that the new laws do not exclude microorganisms unless they are defined, or "accepted", as plants. He also believes that patents on new strains of plant might be gained through the Plant Variety and Seeds Act—a hitherto untapped law for attempts to patent living things, he says.

A delegate asked N. Wallace, head of the relevant section of EPO, whether it was possible to patent a plasmid or a phage. The answer was that as the EPO was not going to allow protection of microorganisms, it could hardly allow parts of them to be patented. □

● The entry of the Commission of the European Communities into the arena with its attempt to establish European safety measures for genetic engineering also came up at last week's Select Committee hearing. The MPs raised the issue in question, and there was a memo from the DES on the subject. This says that "it is not clear that the Treaty of Rome establishing the European Economic Community provides the basis for an instrument to control research in Member States." The Commission is trying to introduce the proposal on the grounds of harmonisation of economic development. The DES says that before any action can be taken the issue will have to be discussed in Brussels "in view of the uncertain nature of this remit in the case of a research field such as genetic manipulation".

Has the DES been dragging its feet on this matter, Nigel Forman asked Shirley Williams. It is the French who have put forward the legal objections, she told the MPs. And that while the DES has "no theological objection to a directive" these aren't all that easy to change once they are implemented and perhaps the best approach for the EEC is through a recommendation, not a directive. □

This week

continued



Novosti

Soviet clean-up of Lake Baikal stagnates

A leading Soviet scientist involved in the battle for the survival of Lake Baikal has warned that "the dangers of pollution to Baikal and the destruction of its unique ecosystem remain very real". Gregorii Galazii is director of the Limnological Institute, the main scientific centre working on the problems of Lake Baikal, and his conclusions, published in the monthly science magazine *Priroda* (1978, no 8, p 44), are based on studies of the lake done over the past few years.

In his article Galazii dwells on the detrimental effect of the Baikalsk pulp mill. The decision to build a large pulp and cellulose mill on the southern shores of Lake Baikal caused a storm of protest in the 1960s (*New Scientist*, vol 71, p 277). It does have an elaborate purification system for its discharge waters but the effluent standards were established hurriedly, without due regard to scientific evidence concerning the protection of Lake Baikal. Galazii criticised this at the time; and, it seems, time has proved him right.

He describes in his article how a steadily growing area of the lake is being affected by the industrial waste waters from the mill. Only 30 to 40 per cent of the organic pollutants being discharged into the lake, such as cellulose, are destroyed each year. The rest remains, along with virtually indestructible mineral substances, to add to the growing polluted zone. This now covers hundreds of square kilometres and reaches to depths of over 250 metres.

Studies by the Limnological Institute show that the discharge waters of the Baikalsk mill, despite purification and dilution, can still harm many plants and animals. Fish caught near the polluted zone are noticeable for their stressed condition, according to Galazii. They contain high levels of particular "stress" hormones (corticosteroids), suffer mutations in body and sexual cells, and often display behavioural changes. The growth of plankton has slowed down, while the number of putrefying bacteria has multiplied considerably.

Changes have also taken place among

shore organisms. Galazii mentions, for example, that out of 49 species of amphipods, which include shrimp-like crustaceans typical of the shore region, only 15 have been found in the polluted area. There was also a much higher mortality among these animals in the polluted waters than elsewhere—50 per cent dying in 16 days compared with only 6 per cent in the control group.

Apart from the Baikalsk Mill, Galazii cites the waste waters of the Selenga pulp and cellulose mill and of the Ulan Ude industrial region as other important sources of pollution to the Baikal ecosystem. These industrial wastes are discharged into the Selenga river, one of the main rivers flowing into Lake Baikal. Although the Selenga runs for more than 120 km from Ulan Ude before it reaches Baikal, it cannot cope with the volume of pollution being discharged into it. According to Galazii, over the past few years the organic content of the river has risen one and a half times, oil and petrol from boats have almost doubled, and there is now a significant presence of sulphates, chlorides, phenols, and organo-sulphur compounds. The colour of the water is also changing. Up to 1500 sq km of Baikal are now polluted around the mouth of the Selenga, and the spawning grounds of the famous Baikal Omul are badly affected below

Ulan Ude, with over 50 per cent of their roe destroyed.

Galazii concludes that the ultimate solution must be no discharge of waste waters, even purified, into either Lake Baikal or its inflowing rivers. But for the time being he puts forward five proposals to try and reverse the present trend of increasing pollution in the lake.

The Baikalsk mill should either stop pulp and paper production altogether, or should discharge all its waste waters beyond the boundaries of the Baikal basin. Galazii also suggests the Selenga pulp mill should move over to a "closed system" and the residual pollution should be discharged into the nearby Klyukvennaya ravine. Another way to save Lake Baikal is to discharge the Ulan Ude industrial wastes deep into the bowels of the Earth where they could not affect the ground waters or the water flowing into the lake.

Timber logging on the lake and inflowing rivers should cease, and there should be a thorough purification of all gas and dust emissions from industrial installations in the Baikal basin.

It seems unlikely that Galazii's proposals will have much effect unless he can whip up some powerful government support and public opinion behind them. The movement for the preservation of Lake Baikal, waged strongly in the 1960s and early 1970s, seems to have faded into inertia as limited steps, such as the purification of the Baikalsk pulp mill discharge waters, came into effect. However, clearly, as Galazii's proposals testify, not all the government decrees issued at that time have been carried out. Both the ending of timber logging and the disposal of the Selenga mill's wastes in a nearby ravine were definite proposals put forward by the government in 1971 and not acted upon.

The government has turned a blind eye to the ecological damage of the increasing and inevitable development of Eastern Siberia, following the construction of the Baikal-Amur Magistral railway to the north of Lake Baikal. And the anti-pollution measures already taken appear to have lulled the government, if not the scientists, into complacency over the quality of Lake Baikal.

Sarah White

Cold water on Siberian canal

Channelling part of the water from Siberian rivers to the south of the USSR will not cause any adverse environmental changes. This is the conclusion of Professor Nikolai Koronkevich who is the senior geographer in the team carrying out a scientific analysis of the project during the current five year plan (*Soviet News*, 13 February). The team's best plan involves a 2000-km long canal deep enough for navigation from the mouth of the Tobol river on the Irtysh to the Aral region of Kazakhstan.

However, not all scientists are happy, even with this project, which is meant

to have the smallest possible effect on the environment. At a recent conference in Akademgorodok, speakers pointed out that the construction of the canal itself is a major project. It would involve more men and resources than the building of the Baikal-Amur Railway and they questioned whether it would not be better to spend such funds on developing agriculture in Siberia. They also said that if the world's climate is getting warmer because of more atmospheric carbon dioxide then rainfall will increase, doing away entirely with the need for the canal. □

US reviews safety levels in uranium mines

Uranium mines in the US are the focus of a new campaign of "blitz" inspections by the US government after new evidence showed that industry figures understate the amount of radiation their workers are regularly exposed to. Uranium mine firms report levels of exposure to radon daughters (respirable alpha particles) on their own, but a three-year audit by the government recently found miners' average exposure to be several times the industry figure, and above the maximum specified by law. But it wasn't until the union that speaks for uranium miners complained of "massive under-reporting" by the mine owners that the government announced specific inspection plans to double check their figures.

The US Mine Safety and Health Administration enforces exposure limits based on workers' exposure over time, of "working level months" (WLM). The limit for one year for a miner is 4 WLM. In 1978, industry said miners averaged 1 WLM a year, but the US mining agency found the average was actually 4.64 WLM, almost five times that reported, and above the recommended limit.

Now, instead of one US inspector trying to assess radiation levels at random points within a mine, a group will descend on a mine to cover simultaneously as many points as possible. There will be more inspections, too, and better record keeping will be required. The idea is to prevent a company from adjusting the ventilation from one area of a mine to another to minimise radon daughter levels, a technique the agency

suspects industry may have used to make its averages look good on paper. As radon daughters are found in many types of mines other than uranium, the "blitz" approach may be used elsewhere.

But critics of current measurement techniques say that more inspections aren't enough. One problem lies with the way industry is allowed to sample. If a mine area is found to have 0.2 WLM at any one time, a miner is credited with that amount (multiplied by his hours at that workplace) until the next measurement, even though the level will probably fluctuate. At some mines, notes government health specialist Max Slade, ventilation is turned off at lunch or after a shift. "We found that a work area that had a radon daughter concentration of 0.2 working levels during the middle of the morning and afternoon would have concentrations as high as 17.0 working levels during the first hour after lunch or starting of a shift." Union officials say the government should exact higher dollar penalties for under-reporting.

Even if the government could be sure the industry is obeying its guidelines there is, however, some doubt that the 4.0 WLM maximum is really safe. A study by Dr Edward Radford, who gave evidence for the Network for Nuclear Concern at Windscale, shows that underground miners in Sweden exposed to radon daughters are contracting lung cancer at rates higher than expected. The miners in the study had been exposed at or below the US level. A summary of Radford's work outlined in a US government memo notes that, "even at dose rates well below the current US

standard, an excess cancer risk is observed." The memo adds: "The Swedish data indicate that radon daughter exposure remains a serious problem, and that the current US standards should be reviewed in light of these Swedish results."

Mine Safety and Health Administration industrial hygienist H. P. Richardson says the agency is reviewing the 4.0 WLM limit, which was set in the early 1970s. "We haven't been working at those levels long enough to fully understand the effect of them," he says, adding that it probably will take 5-10 years to fully assess the effects of that level. Pressure for a conclusive study is likely to mount soon, however, given the fact that uranium mining is expected to increase in the next few years. Also, recent studies have turned up abnormal rates of cancer in shipyard workers, nuclear power plant employees, and soldiers on nuclear test-sites, all of whom were exposed to what was once considered safe amounts of low-level radiation. □

Scientists nearly keep up with the Jones

Scientists and engineers made substantial gains in salaries during 1978, but in many cases the increases were not enough to balance out the ravages of inflation over the past few years. This is the main conclusion to be drawn from the four big surveys of scientists' and engineers' pay carried out by the Royal Institute of Chemistry and the institutions of civil, mechanical and electrical engineers. The surveys, synchronised to look at salaries on 1 January, 1979, show the following pattern:

| Group | 1979 median | 1978 median | per cent increase |
|-------------|----------------|----------------|----------------------|
| Chemists* | 8000 | 7140 | 12 |
| Civil* | 7500 | 6680 | 12.3 |
| Mechanical* | 8050 | 7000 | 15 |
| Electrical* | 8250 | 7100 | 16 |

*Fellows and members.

These salary increases are, however, tempered by inflation. For example, in 1979 fellows and members of the Institution of Civil Engineers (ICE) had median earnings of £5354 adjusted to 1976 prices. In 1976, they earned £5800. Thus the purchasing power of their earnings has dropped. Scientists and engineers have not done as well as other workers. Civil engineers, for example had a median salary index of 89.9 in 1978 (1976=100), whereas other non-manual workers had an index of 97.3.

Another trend apparent from the surveys is that the lead in salaries opened up in recent years by scientists and engineers in the public sector over their colleagues in the private sector has been closed. For example, private sector chemists at the maturity of their careers (in their 40s and early 50s) now earn £500-800 more than those in the public sector. Similarly, private sector civil engineers are £250 ahead of public sector colleagues. Mechanical engineers in the private sector have a £350 lead.

Plutonium trial reopens safety debate

The tangled case of Karen Silkwood got under way in Oklahoma City last week, more than four years after the nuclear worker died in a car accident while travelling to see a newspaper reporter and a union official about her allegations of sloppiness in the Kerr-McGee plutonium plant in which she worked. The trial doesn't involve her death, although there have been murmurings of evidence that it might not have been accidental. Rather Silkwood's estate is suing Kerr-McGee for \$11.5 million for anguish that the estate claims Silkwood suffered on finding that she was contaminated with plutonium. Lawyers for the huge nuclear company have suggested that Silkwood was responsible for the contamination.

But the struggle embraces much more than the obvious issues. The case has become a cause célèbre to US opponents of nuclear power with many of the cult figures of the anti-nuclear establishment gathered in the courthouse at the time of the incident.

The 24-year-old Silkwood's work was checking pellets of plutonium to be used in a government-run fast breeder reactor. She also acted as a negotiator for the Oil, Chemical and Atomic Workers Union.

On 5 November, 1974 she reported that a routine check showed her to be contaminated with plutonium. On the following two days investigators from Kerr-McGee and the Atomic Energy Commission, the organisation that at the time ran nuclear affairs for the government, found traces of plutonium in Silkwood's flat.

Just how it got there is a mystery. Silkwood supporters have suggested that Kerr-McGee somehow caused the contamination in order to silence a worker who was becoming too vociferous on safety issues within the plant. The company hints that Silkwood herself took the plutonium home with her but Silkwood's lawyers say that the company must bear the ultimate responsibility, even if simply through negligence.

The trial will undoubtedly be a long and extremely contentious one. A preview of the fireworks came last week when John Gofman, a long-time critic of government and industrial authorities in nuclear power, testified that advice manuals on handling plutonium at the Kerr-McGee plant, which has produced plutonium since 1975, were inadequate and contained false information. □

This week

continued

Lyons' share for ship scientists

Scientists and engineers at the British Ship Research Association (BSRA) have won a "fair wages" claim of 10 per cent of their basic salaries, to bring them into line with government-employed scientists and engineers doing the same kind of job. The award is claimed by the Engineers and Managers Association (EMA)—which won the right to organise specialist research staff at BSRA late last year—as being the first of its kind for a research association. The General Secretary of EMA, John Lyons, also makes the point that the award is 2

per cent higher than that won by other white collar unions at BSRA.

Lyons is ambitious for EMA to become the natural union for all "professionally qualified" people, and he includes groups like accountants and surveyors as well as scientists, engineers and managers who are not already members of unions. To make his point he says that should the next round of pay negotiations for the electrical power engineers go to industrial action, he will "fight it in the name of all engineers and scientists in industry". □

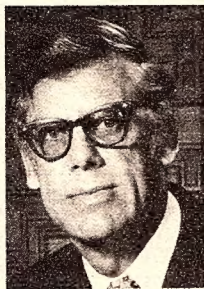
Space feet on the ground

The Space Shuttle has a good chance of making its first orbital flight on 9 November, as long as no major new problems are encountered by July, when the vehicle is stacked vertically for launch, says John Kiker, chief of the Mechanisms Branch of the Spacecraft Design Division at NASA's Johnson Space Center. Kiker was in London last week on a private visit to look at possible ways of using his expertise when he retires in about 18 months, at the age of 55 and with 30 years in NASA and its predecessor behind him.

Kiker is definitely a space enthusiast; he joined the programme in 1959 soon after its inception, and received NASA's highest award for showing that the Shuttle Orbiter could be safely transported, piggyback-fashion, on the top of a Boeing 747 airliner. The space administration had been looking for a way of taking the Orbiter aloft for its unpowered approach and landing tests (ALT), and of ferrying the vehicle among factory, test site and launch base. Most people thought that interaction between the two sets of wings would be prohibitive, but Kiker—a model-aircraft enthusiast—built a scale replica of his "big biplane" and showed that it would work.

NASA's goal is still what it always has been: the exploration of space for the benefit of all mankind. Kiker says that those working on space projects still have as much incentive as when they had a definite and unalterable timetable—an assassinated President's pledge of a Moon landing within the 1960s—but that the programme is not given as much emphasis in government circles as he would like.

Kiker believes that space exploitation already provides a good return on investment in the fields of medicine, weather forecasting, telecommunications and other areas, and the Space Shuttle will give a massive increase in the load which can be flown in space and then returned to Earth. The Mercury capsule weighed only 2700 lb and even Apollo was a mere 13 000 lb,



but the Shuttle—known within NASA as the space truck—weighs 200 000 lb and can carry 65 000 lb of payload.

The Shuttle will build up to a schedule of one flight a fortnight, and Kiker likens the present stage of development to the early days of aircraft. There was a time when people asked what practical use an aircraft could be put to, he points out, but nowadays Kiker and many like him think nothing of commuting the 1500 miles from Houston in Texas to California for a day's work.

Kiker is responsible for "everything that moves" on the Space Shuttle and believes that cross-fertilisation of ideas between the US and Europe is responsible for the Spacelab orbiting laboratory and can do nothing but good. The Canadians are also involved in the project and the Japanese are likely to take a larger part, so the Shuttle is already proving to be a catalyst for international understanding.

Kiker also believes that NASA has an important role to play in educating industry as to what hardware the administration has developed. This includes items as diverse as a polymer which will conduct electricity; a sparking plug which produces a ring of energised atoms, rather than a point ignition source, allowing low-grade fuels to be burnt in a "weak" mixture; and a gas valve with no moving parts which operates by applying a magnetic field to fibres of crystalline nickel in a cylinder, causing them to stretch instantaneously when the valve is "opened."

Another area in which he believes NASA can play an educational role is in bridging the gap between universities and its own immense pool of applied research. Last summer two professors spent 10 weeks each with Kiker, sponsored by grants from the National Science Foundation, and they were able to feed their "coalface" experiences back to students and thus relate theory to application much more directly.

Mark Hewish

Seven Days 4 March to 10 March

5 MARCH EMI Medical Limited signed a contract with representatives of the People's Republic of China to supply two EMI-Scanner computed tomography systems and an advanced radiation therapy planning system, worth in total over \$1 million. The equipment will be installed at the Cancer Institute in Peking.

5 MARCH The chairman of the Science Research Council, Professor Geoffrey Allen, sent out a letter encouraging scientists throughout the country to apply for grants for new equipment needed for advanced research. The council now has some spare cash to spread around, but is not keen to commit itself to long-term projects because of uncertainties about funding in the future. Applicants are urged to get their suggestions in before 1 April, the closing date for this round of allocations.

5 MARCH Alex Eadie, Under Secretary of State for Energy, answered a question in the House of Commons on what percentage of Britain's energy is derived from space satellites. He said: "None. Solar energy is used to power space satellites but the technology does not exist to enable significant quantities of energy to be relayed to Earth by radio. Such a development would be extremely expensive and could pose serious environmental problems."

7 MARCH NASA announced its plans to explore Jupiter's moons with an even more advanced spacecraft than Voyager 1. The new spacecraft, named Galileo, will visit 11 of the 13 Jovian moons by using the gravitational pull of each to speed it on its way. It will also send a spaceprobe into Jupiter's atmosphere to analyse its chemical composition.

8 MARCH The European Space Agency and the Council of Europe announced a new concerted European research programme on earthquake prediction which could become operational around 1990, although the preparatory phase is due to start right away. The programme calls for collection of data from satellites and 150 ground stations in the Alpine-Mediterranean seismic belt, running from the Near East through the East Mediterranean, the Aegean, the Balkans, the Apennine and Iberian Peninsulas to the Azores.

THE NEW SCIENTIST 20 years ago

The key to development in this part of Asia is undoubtedly power. Looking to the future, there is every reason to believe that nuclear power will have to be used also, because known coal reserves have their limitation, oil reserves are negligible and even the vast hydroelectric potential is inadequate for expected needs. India will soon be commissioning her second reactor at Trombay; this NRX reactor is being built by the Canadians, and though it will not produce useful power, it will enable Indian nuclear engineers to gain valuable experience with this new source of energy. Since India has large deposits of monazite sand, she need fear no shortage of nuclear fuel.

The New Scientist, 12 March, 1959.

Race, intelligence and education

The debate on race and intelligence flared up again recently, with the publication by the National Union of Teachers of a pamphlet by Steven Rose and Ken Richardson that claimed to be "a teacher's guide to the facts and the issues". That pamphlet was criticised by Hans Eysenck as being extremely biased and factually incorrect. Since then we have been trying to get the two camps to clarify their positions. We asked the main protagonists to respond to four questions on the understanding that their replies would be published with no editing. Here, then, are the answers of Hans Eysenck and Steven Rose to the following questions

What is the validity of using IQ tests as measurements of intelligence or ability?

Is the concept of measurable heritability applicable to IQ?

What is the evidence for differences in IQ associated with race?

If there are links between race and intelligence, how should they be incorporated into educational policy?



Camera Press

Hans Eysenck

is professor of psychology at The Institute of Psychiatry



Richard and Sally Greenhill

Steven Rose

is professor of biology at the Open University

DO IQ tests measure intelligence? The question sounds meaningful, but it does not seem to be readily answerable in that form. Intelligence is not some *thing* that exists somewhere out there, like a table or a pig, when it would be sensible to ask: Is this a table, or a pig? Intelligence is a *concept*, like mass, or temperature, or weight; it is defined in terms of a nomological network of theories and hypotheses, and cannot be divorced from this theoretical substructure. Theory says that all cognitive performances are to varying degree a function of a single underlying ability (intelligence or *g*), plus a number of specific abilities (numerical, verbal, perceptual, etc), plus quite specific factors not shared by different tests. Such a theory makes predictions that can be checked, for example that all cognitive performances should correlate together (positive manifold) and the resulting matrices should have a low rank (approximately rank one), and the like. These and other predictions have been shown to be verified when the requisite precautions are observed (for example, testing random samples of the population), and in so far we must say that the theory is in good accord with reality. This is the method of internal validation.

The method of external validation asks—to what extent is this *g* identifiable with what the man in the street calls intelligence? This point is of less scientific interest, partly because the man in the street has only very muddled and inconsistent ideas about intelligence; nevertheless, we would expect *g* to correlate positively with educational success, and negatively with mental defect diagnosed in terms of conduct. We would expect occupations demanding a high degree of ability (physician, pilot, professor, manager, journalist) to be characterised by higher IQ than occupations demanding a lesser degree of ability (dustman, nightwatchman, unskilled labourer). We would expect people generally regarded as intelligent to score higher on IQ tests than people regarded as dull. All these expectations are amply fulfilled. Last, we would expect correlation surfaces, plotting IQ against educational or professional success, to be heteroscedastic (because high IQ is a necessary but not a sufficient condition of success); this

IN one form or another these questions are a century old. Science has moved on. The concepts of human "intelligence" and "race" are now known to be devoid of biological meaning and serve only to obscure important scientific and social issues. Yet the questions continue to be asked, primarily because of the social functions their ideological presuppositions serve in the context of contemporary Britain. Biology's task here is to help rescue psychology from the almost medieval scholasticism of some of its protagonists. Eysenckian psychometry uses two schoolman's tactics; argument "from authority", citing long outdated claims by earlier schoolmen as if they were fresh and had not been oft-refuted; and claiming the debate lies between "objective", "scientific" "hereditarians" and nice but soft-minded "environmentalists". This is not a sort of single-handed gladiatorial combat between me and Professor Eysenck, in which truth lies somewhere between two extremes; the issues at stake are the distinction between sense and nonsense, biological knowledge and magical prescientific thinking, and between these two there can be no halfway houses. Modern biology has transcended the name-calling dichotomy of hereditarians versus environmentalism and is moving towards an *integrated* accounting of genetic and environmental factors in the development of the individual and the species.

The fallacy that "IQ" tests measure intelligence is a classic example of circular reasoning, based on a series of untenable assumptions: (a) that intelligence is a sort of *thing*, a fixed quantity which is embedded in the brain (b) that the quantity of this *thing* can be assessed like weighing butter in a supermarket (c) that it is possible to number off and rank order people by the amount they possess. But we can only observe intelligent behaviour in our fellows in the context of a historical and developmental process in which individuals are actors in a complex system. Into this process go many things; aspects of the biology, personal biographies and social situation of the individual.

The assumption of a global "general intelligence factor" has been discarded by most modern psychologists working on cognition as virtually useless for understanding the

Hans Eysenck

too has been found to be so. External validation may then also be said to be forthcoming.

Can we say anything meaningful about the heritability of the IQ? Geneticists like R. Fisher, FRS, K. Mather, FRS, and J. Jinks, FRS, think so, and I have heard no serious argument to suggest otherwise. Obviously we cannot use the method of animal breeding studies in humans, but there are many different methods that can be used to give us leverage on the problem. We can study MZ (identical) twins brought up in separation; we can compare MZ and DZ (non-identical) twins brought up together; we can look at familial correlations, relating observed with predicted correlations in terms of degree of consanguinity; we can test adopted children and compare their IQs with those of their natural and their adoptive parents; we can look at the incidence of assortative mating for clues about non-additive genetic factors; we can look at "inbreeding depression" for evidence on directional dominance. All these and other methods have been used, and the results can now be analysed much more rigorously by means of the biometrical genetic methods associated with the Birmingham school of genetics than was possible previously. When this is done, as Dr D. Fulker and I have shown in my book *The Nature and Measurement of Intelligence*, leaving out Sir Cyril Burt's doubtful data, and taking into account justifiable criticisms made by Leon Kamin and others, we arrive at results of remarkable consistency, indicating a heritability of something like 70 per cent of the broad heritability, ie including assortative mating and dominance in addition to the simple additive genetic factors. This figure applies to raw IQ scores; when corrected for unreliability it rises to 80 per cent.

It is important in this connection to realise that the geneticist is not primarily concerned with heritability; he is concerned with writing an equation which would include all sources of variance related to phenotypic variability. This inevitably includes environmental sources of variation, as well as at least two sources of interaction—simple interaction and correlated environments. Much of his information comes from experiments along the lines described in my last paragraph; much also comes from experiments directly testing for environmental effects. We can correlate environmental variables with IQ, for instance, or we can reduce environmental variability as much as is humanly possible (for example by testing orphanage children, brought up together since early in life). Results from such studies, too, agree well with estimates made from direct genetic experiments. It must be concluded, I think, that we can say something meaningful about the inheritance of intelligence in humans, and no doubt the accuracy of our quantitative estimates of heritability and the other portions of the genetic equation will be much improved by future research.

Are differences in IQ associated with race? There are really two parts to this question. On the observational level there is no doubt that the answer must be yes; different ethnic subgroups have been shown to give consistently different mean scores in IQ tests. Thus Japanese and Chinese children and adults score consistently higher than do whites, whether the testing is done in their own countries, or in the United States. Malays score some 15 points below Chinese and Japanese. American blacks score some 15 points below American whites; American Indian also score rather low. Eskimos in their natural habitat score about the same as whites, that is, below Japanese and Chinese, and above blacks, Chicanos, and American Indians. Within the European groups, differences probably due to differential emigration and immigration can also be found; neither "whites" nor "blacks" can be said to constitute homogeneous groups or races in this sense.

Steven Rose

processes underlying "intel-
ligent behaviour". The term merely obscures the interaction of specific and specialised cognitive processes. Such a conclusion is also strongly supported from neuropsychology which has shown that many different human cognitive systems may be damaged in isolation from others, leading to specific, and not general, cognitive defects. Such an understanding is also derived from neurobiology and developmental genetics. In the face of modern scientific understanding the attempt by Eysenckian psychometry to extract and quantify a bump of intelligence out of this complex is as fallacious and outdated as phrenology.

The IQ test is not an index of fixed biological potential, but a particular social construct, a set of carefully selected items intended to distribute individuals on a single dimension across a magic (nearly) normal distribution bearing some relationship to school exam results. Social judgements determine the test construction. On early versions of the Stanford-Binet (the historically "basic" IQ test), boys and girls scored differentially. The testers decided this was unfair and adjusted the differential scoring items until the differences vanished. Neither before nor after the adjustment was the test telling one about "biological reality"—but it was saying something about the social factors which determine the acceptability of test results. This is still true today.

Eysenckian psychometry, however it tries to biologise itself by arbitrary pseudo-physiological correlations, is reduced to the sterile statement that "intelligence is what IQ tests test", whether the tests are of the Stanford-Binet type or the more recent so-called "culture-fair" ones.

The genetic arguments need to be clearly understood. The issue is not about whether a trait is environmentally or genetically determined. It is here that the heritability measure comes in.

It is above all the meaning of measures of heritability that Eysenckian psychometry most conspicuously misunderstands. The claim is that if IQ is a biological phenotype (and I have emphasised that it is not) it must be possible to parcel out differences in individual IQs between genetic and environmental components. Quantitative population genetics is still in its infancy and one of the few tools it has available is the heritability measure, a particular piece of biometric algebra which has a precise but limited meaning. It does not mean the same as "inheritance" in the popularly understood sense at all. In the case of IQ, the trouble begins with the fact that most of the primary data concerning IQs of variously related individuals, upon which the estimates are derived, much collected many years ago, seems on re-analysis to be fatally flawed so that no reliable conclusions can be derived from them. As Leon Kamin has shown, it is not merely Sir Cyril Burt's work which must be rejected on this score. However, there is a much more fundamental problem which lies in the nature of the heritability estimate itself. Biometricians know that (a) to measure heritability requires a breeding study in which different genotypes are more or less randomly distributed through a limited range of environments; (b) it gives a figure which is meaningful *only* for those environments (if the environment changes, the heritability also changes); (c) it can only be derived for traits in which there is a limited interaction between genetic and environmental components so that variances are additive; (d) it is only a within population statistic—it tells us nothing about differences *between* populations and there is no theoretical or practical technique available to genetics which can do this; hence, for instance, it can say nothing about the origins of differences in a trait between White or Black groups.

It follows that however sophisticated the algebra, statistical procedures and data that are fed into it, the heritability estimate can give no meaningful information



The second question that can be asked is the causal one—are these differences due to environmental factors, or are they genetically caused? As I pointed out in my book on *Race, Intelligence and Education*, “the discovery of within-race genetic factors determining IQ differences is a *necessary*, but not a *sufficient* condition for accepting the genetic argument as applied to between-race differences. Can we go beyond this and argue that genetic studies . . . give *direct* support to the hereditarian position?

The answer must, I think, be in the negative”. (Most of my critics seem to labour under the illusion that I maintain the opposite; reasons for this misinterpretation are obscure to me.) Arthur Jensen’s hypothesis that there are genetic causes depends essentially on circumstantial evidence demonstrating that alleged environmental factors cannot in fact account for observed differences, leaving genetic causes as the most likely determinants. Socio-economic status, or better education, can hardly account for the superiority of Chinese and Japanese, or the equality of Eskimos with whites; neither can the fatuous argument that IQ tests are made by white, middle class psychologists to favour white middle class children. Black and white children, equated for socio-economic status of their parents, housing etc. still show an IQ difference of 12 points. Race of tester has been shown to make no difference to the outcome of tests. The difference in IQ between blacks and whites has not diminished over the past 50 years, although in comparison the socio-economic status of the blacks, their education, and their general acceptance have all increased tremendously. Blacks have been said to be disadvantaged by verbal tests, due to educational disadvantages, but they show greater inferiority on non-verbal tests than on verbal ones. Opponents of the genetic hypothesis have in fact been reduced to argue for some unknown environmental factor X as being responsible; such an hypothesis is of course impossible to disprove.

What are the consequences of the observed relationships between race and intelligence, as far as educational policies are concerned? The first point to make is that the demonstration of a large area of overlap between races infirms the basis of all racist positions, namely that one race is totally superior to another. With the amount of overlap observed, we cannot judge a person’s IQ on the basis of his skin colour; we must disregard his race, and judge him solely on the basis of his demonstrated ability, personality, temperament, behaviour, and attitudes. As I pointed out in *Race, Intelligence and Education*, the question of colour is simply a red herring; the problem is low intelligence, whether in white, black or yellow children. Racial differences appear meaningful only when dealing with large groups; thus an influx of groups having a low mean IQ would alert a wise Minister of Education to the need for more ESN classes; this could be of considerable importance in providing much needed facilities that might otherwise not be forthcoming.

As regards the more general problem, there is evidence that different methods of instruction may be appropriate for children of different IQ; Jensen has made important suggestions in this direction, based on experimental studies of his own. It is not suggested that “better” methods of education should be reserved for brighter children; merely

about a trait like human intelligence. Its use obscures the important and sensible biological questions that need to be asked.

This is why the question of the heritability of intelligence is not about more research being needed, or less emotion, or more scientific responsibility. Despite its apparent reasonableness, the question “How much does genetics and how much does environment contribute to differences in intelligence between ethnic or social groups?” is on a par with “How much does Camembert and how much does Stilton contribute to the composition of the Moon?”

Those gene differences in human traits which have been studied vary continuously, not discontinuously, across the entire human population of the globe. Ethnic minority groups are overwhelmingly biologically (genetically) similar to their host populations, not different. There are sensible and often interesting questions to be asked about the distribution of particular traits across populations when they can be adequately measured. The study of blood group proteins is one example; another, where there are discontinuities which do have potential social significance, are single gene defects like sickle cell anaemia. But “average” statements about socially defined groups (Blacks, Jews, Asians, or whatever) carry no biological weight. The persistent assumption that biological differences underly social race ascriptions is one of the archetypes of racist thinking; modern population biology is more and more coming to discard the concept of distinct human races as having no *biological*, as opposed to social, meaning.

Just as there are differences between social groups on school performance, so there are on IQ measures. On average, working class children score lower than middle class, while in Anglo-Saxon cultures there may be differences between the average IQ scores of ethnic minorities and that of the majority population. The direction of these differences varies. In the US and possibly Britain, children of Chinese or Japanese parentage seem to score on average higher than indigenous Whites, Black children lower. Whatever these differences mean, biology has little to do with them.

The irrelevance of genetics to IQ differences is shown by the very large intergenerational differences in IQ relativities between social and ethnic groups—in the 1920s IQ tests in the US showed Jews as definitely “inferior” to the local WASP population; today, if anything the reverse is the case. No genetic mechanisms could produce such a reversal. The reasons for IQ differences must thus be sought in discrepant cultures, languages and social experiences within xenophobic societies.

That IQ scores differ, on average, between different groups, says nothing about the origins of such differences or about their permanence; it is an artefactual consequence of the fact that tests are a social construct designed to predict school performance and conformity to the dominant ideology of the society within which they are constructed and by which they are used. It is possible to devise tests on which working class children score as well or better than middle class, or on which children of Caribbean descent in Britain score as well or better than those of indigenous descent, just as it was possible to equalise male/female average scores in the Stanford-Binet. Evidence from such tests however is rejected by Eysenckian psychometry, or





that the methods used, and the aims set, should be adapted to the intelligence (and the personality!) of the individual child (regardless of colour) in order to bring him up to the maximum level his potential warrants. It is one of the sad consequences of the politicisation of the scientific argument about the inheritance of the IQ that little serious scientific work is being done in this field; for the sake of our children this should be rectified. Quota systems, such as the "affirmative action" system introduced

in the US, are certainly not the answer; the consequences in American education have been unfortunate, to say the least. Such systems have also been tried (and failed) in communist countries, like Rumania.

It is quite wrong to think that the positions of the opposing groups on this question are related to political thinking; the official Marxist position does not in fact differ all that much from mine. J. Guthke, in a book on intelligence published in the East-German Republic under the aegis of the communist government publishing house, points out that "Marxist psychology does not deny the importance of genetic determination for the differentiation of intelligence. . . . Both Marx and Lenin have always emphasised the biological and psychological inequality of human beings." The problem is one for scientists to solve, not for politicians to haggle over. □

they are arbitrarily designated as testing "lower order skills", thus completing the circularity of the argument.

The central question is how to educate all our children to their creative full and how to make adequate social use of these creative talents. Examining and assessing children's school performance and achievements is one method of discovering how well the first of these goals has been achieved, and the results may tell us something important educationally about

individual children, teachers, and teaching and learning methods. But education in Britain does not take place in a social vacuum or social utopia. Educationalists must battle against the problems of decaying schools, inadequate textbooks, overlarge classes and the prospects for the children they teach of unemployment or routinised, alienated labour. Children from ethnic minorities in addition confront the social facts of racial prejudice inside and outside the schools. Overcoming these problems are social objectives to which biology at best could have little to contribute and towards which the concepts of biologically defined "races" and "intelligence" are nothing but obstacles, empty mystifications to be seized upon by racists to justify a prejudiced *status quo*. Their social functions are to hinder us from *either* understanding *or* changing our world. □



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This desk top computer is specially designed for the sort of calculations commonly carried out in science and engineering. Based on 2 micro-processors, it employs a new programming language called BURP (Basic Using Reverse Polish). A high quality display is achieved by feeding an output signal directly to the tube of a domestic TV set. An ordinary cassette recorder can be used to record computer programs. You can build this extremely versatile research instrument - just by following the series beginning in this issue.

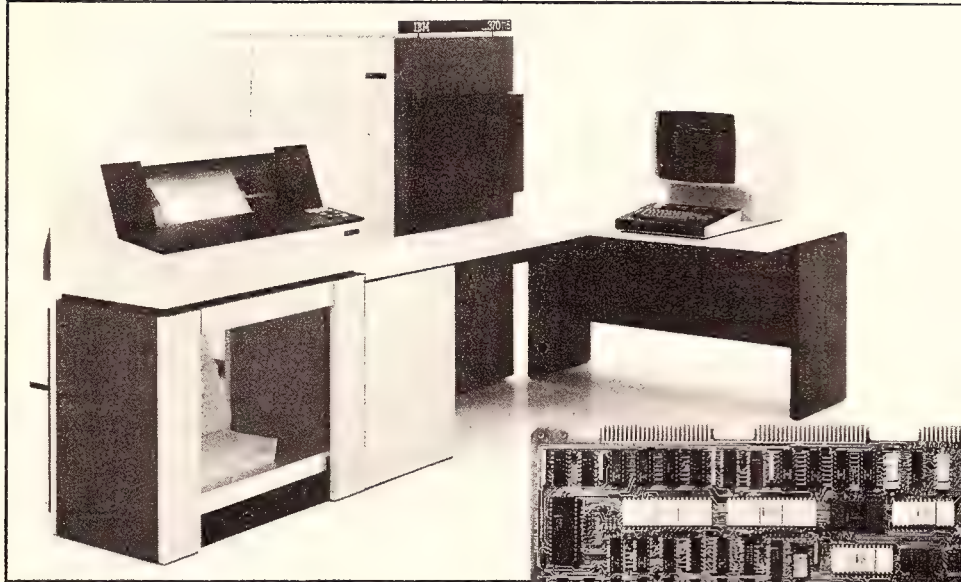
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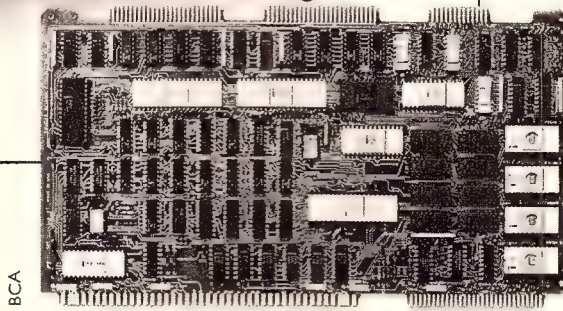
April issue Out now 40p.

Multiple micros - menace to the mainframe

Before microcomputers put production-line workers on the dole they will pose a threat to those craftsmen-tooled, lovingly-assembled, mainframe computers. But could the same craftsmen use the insidious chips as building blocks for large computers? They are certainly trying



Today's mainframe has big components—for example this IBM 370's chest sized processor. Tomorrow's multi-processor will make use of components like Intel's "single board computer" (inset)



Mark Dowson
runs his own computer
consultancy
and
Brian Collins
is with Scicon
Consultancy

"big is best". But designers of big "mainframe" computers are now glancing over their shoulders at some recent developments that threaten to oust traditional mainframes from some of their established territory.

What worries them are attempts to put large numbers of microprocessors together, and make them behave like one big machine. Connecting many little computers into a single "multiple microcomputer" is an obvious idea, but until recently no one knew how to do it effectively. The overheads of complex connection had always outweighed the gain in power. But now multiple processor machines are being rapidly developed.

The impetus, of course, has come from advances in semiconductor technology. This has moved on from the slow, simple four-bit (capable of handling a four character word) microprocessors found in pocket calculators and through the faster more versatile eight-bit micros used in "intelligent" computer terminals, personal "hobby" computers and now gaining a foothold in industrial process control. The industry-standard devices now emerging are powerful 16-bit microprocessors like Intel's recently released 8086, which has the power of a medium-sized minicomputer but at a fraction of the price. Intel's machine will shortly be followed by similar microprocessors from the other market leaders, US companies Motorola and Zilog. All these will be effective substitutes for medium-sized minis in many applications. Many other applications, however, need more power than a single microprocessor can provide. Increasingly

important among these are "real time" systems which must respond to changes as they happen.

Typical real-time systems would control an industrial plant, or provide terminals in branches of a bank to update centrally held information files on customers' accounts and it is these applications which look most attractive as candidates for submission to multiple microcomputers. In such systems a number of "tasks", such as controlling a particular machine or debiting a customer's account, must be performed apparently simultaneously.

The traditional solution for these applications is to divide the time of a large computer between various tasks so that each task is given an appropriate share of the various facilities the computer provides. The problem of

allocating scarce processing resources among competing needs is handled by a program known as the operating system. Just as central management of a complex economy breeds a large and expensive bureaucracy, large and complex operating systems themselves consume large quantities of the resource (computing power) that they control. Also like large bureaucracies, they are so complex that they are difficult and expensive to design and invariably contain errors. As applications grow, and more powerful computers are required, their designs become internally more complex. Slave processors may be added to perform numerical calculations, or peripheral processors can be brought in to manage the flow of data into and out of the machine in parallel with the main activity of the central processor. This in turn leads to even more complex operating systems.

By contrast, in a multiple microcomputer each processor handles only a few tasks at a time and its own operating system can be very simple, efficient, and error free. Because computing power is managed by the individual processors, coordination of the activity of the whole machine can also be (relatively) simple.

If the component processors can be efficiently interconnected, powerful computers can be constructed which would otherwise require sophisticated and expensive technology. The extra power comes more cheaply from the addition of extra processors.

Multiple microcomputers have other potential advantages. Their modular construction can allow incremental increases in computing power to meet increasing requirements without changes to software or operating practices. As they consist of a number of identical units, they are potentially highly reliable.

Digital Equipment Corporation (DEC) of the US, best known for its PDP-11 range of minicomputers, has not been

slow to appreciate the potential of multiple microprocessors. Its experimental PULSAR computer uses up to 16 of its own LSI-11 microprocessors to provide a machine whose power ranges from that of a single LSI-11 to 50 per cent more than its most powerful mini, the PDP-11/70.

Working on the premise that 90 per cent of the cost of a system is in its software, DEC has deliberately sacrificed some of the potential efficiency of this one. It designed PULSAR so that it can be programmed with an operating system which will make it look to the user like a single, standard DEC minicomputer. This operating system, which provides facilities identical to DEC's established and proven RSX-11M real time operating system, will run existing programs without change. As far as the user is concerned,

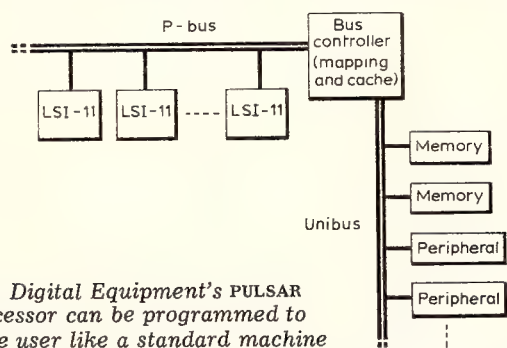


Figure 1 Digital Equipment's PULSAR multi-processor can be programmed to look to the user like a standard machine

the only difference is that he can plug in more processors—to make his programs run faster. But the constraints are considerable.

All the processors in a PULSAR system are connected to its main memory via a single common "P-Bus" and a "bus controller" (Figure 1). The bus controller interleaves attempts by the various processors to get at the main memory, and maintains a fast, "cache" store containing copies of its most commonly accessed parts. This avoids some of the effects of the bottleneck which arises from many processors trying to gain access to the same store. It must also perform "address mapping"; this means translating the 16-bit memory addresses generated by the processors into the 22-bit addresses which are needed to reference the whole of the main store.

Each microprocessor runs independently except when it is executing certain "critical" sections of the operating system program which, for example, could update a table of data which all processors share. To prevent the detrimental effects of interference here, only one processor can execute a critical section at any time. It is this software bottleneck that limits the size of PULSAR to 16 or so processors and, in any event, between 5 and 8 per cent of the operating system itself forms a critical section. Eventually a point is reached when added processors spend their time queueing for access to critical sections, rather than improving performance.

The disadvantage of DEC's solidly commercial approach—in providing a standard operating system—is that there is a limit to how far the power of the machine can be extended. In contrast, Carnegie-Mellon University's (in Pittsburgh, Pennsylvania) CM* (pronounced "see-em-star") multiple processor can be extended almost indefinitely but, according to one of its professors, Dan Siewiorek, "We don't yet know if it is really programmable." CM* uses computer modules each consisting of an LSI-11 microprocessor, up to 128 000 words of memory and a switch (called "S-local") which connects a module to a "map bus"—an address mapping connector. Each map bus connects together as many as 14 modules to form a "cluster". Clusters can themselves be interconnected by address mapping (AM) controllers and intercluster connectors.

Each processor can access the store of any other processor in the system, although the access time increases

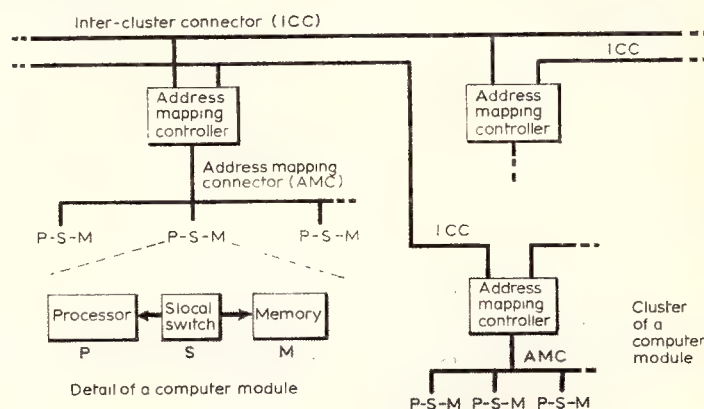


Figure 2 Carnegie-Mellon University's CM* multi-processor should allow hundreds of processors to be connected—but will it be programmable?

proportionally with the remoteness of the store. The S-local switches and the AM controllers have to perform the same kind of address mapping required in PULSAR to allow a processor to address all the memory in the system. The hardware organisation of CM* will allow the construction of systems with up to several hundred processors (Figure 2). But programming it is another matter.

At present, Carnegie-Mellon is trying two approaches. The first is to program each microprocessor individually in a "low level" language which directly and explicitly controls the hardware of the machine. This requires the programmer to understand how each microprocessor will interact with the others in the system and to write the program accordingly—an almost impossible task for really large systems performing tasks which interact in a complex way. The second is to use a large conventional computer to convert a program in a "high level language" to one which will run directly on CM*. The high level language, ALGOL-68, allows the programmer to concentrate on specifying the tasks that he wants accomplished rather than on the details of how the hardware is to perform them, making programming considerably easier. Unfortunately, this approach inevitably breaks down ALGOL-68 programs into small pieces for simultaneous execution and the comparative power drain in coordinating their activity seriously reduces the efficiency of CM*.

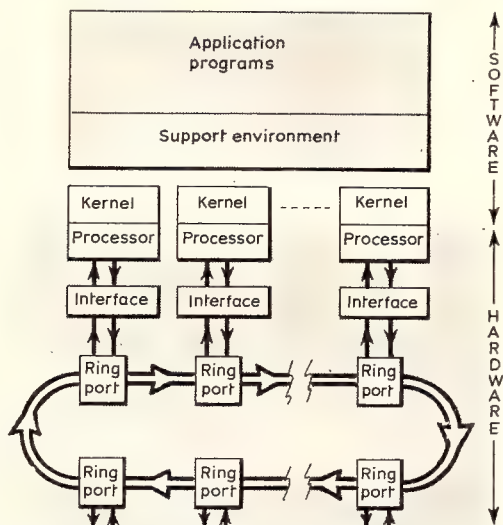
The DEMOS multiple processor, being built by the National Physical Laboratory (NPL) and Scicon Consultancy (at NPL's Middlesex, UK headquarters) was designed specifically to be programmed in a high level language with built-in facilities to control the interaction of simultaneous tasks. Unlike CM*, individual computers in a DEMOS system cannot access each other's stores. Intercommunication is managed by small, simple operating systems (kernels) on each computer. These pass messages through a high capacity communication system. This consists of a set of ports connected by short parallel data links into a ring. Messages for transmission between ports are split up into a collection of short data packets and relayed from port to port round the ring to their destination, where they are reassembled. The total capacity of the ring is around 5 million words per second, which is shared out between 250 ports.

Only the interface between each computer and its ring port needs to be specialised for the needs of the particular type of computer used (in the prototype this is the Ferranti ARGUS 700F minicomputer). Since processors can only directly address their own store, the need for address mapping hardware is avoided.

The kernels automatically manage communication between tasks on different computers to make a DEMOS system look like a single computer. This computer is programmed in "Concurrent Pascal", a recently developed high level language designed for reliable and efficient

programming of operating systems. In it, programs are written to provide a "support environment" tailored to run a collection of programs for particular application. This "layered" approach leads to the design of software which is reliable and easy to understand and modify. The components of a DEMOS support environment are allocated to individual computers by a special program before the system runs. This allows the same program to be loaded onto large or small systems without change. Thus, the hardware can be extended by adding more processors as

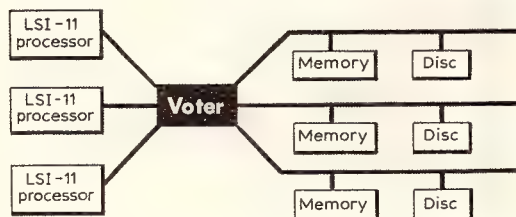
Figure 3
DEMOS, a multi-processor design from the UK, employs a high level language and "looks" like a single machine



the demands of the application increase. Alternatively, if a processor fails, the system can quickly be reloaded onto reduced hardware while it is being repaired (Figure 3).

Although DEMOS allows quick recovery when one of its computers fails, it was not designed with high reliability in mind. A multiple processor designed primarily for high reliability has been built at Carnegie-Mellon University. This is called C.VMP (Carnegie-Mellon Voted Multi-Processor) and exploits the low cost of microprocessors to produce a computer with high redundancy allowing it to survive any major failure of components. In C.VMP the processor, the memory and the disk backing store are all triplicated. The signals in each of the triplets are compared

Figure 4
Carnegie-Mellon's "voted" multi-processor is designed specifically to be highly reliable



and, if they differ, the "majority vote" is used to determine the correct signal (Figure 4). The voter itself could be "voted" on if its reliability were suspect. Functionally, C.VMP is identical to a single one of its component computers (again, the DEC LSI-11) except that it runs at only 85 per cent of the speed. However, it will continue to operate if one processor, memory and disk are removed.

With the exception of C.VMP, in all the systems described, tasks, or sub-tasks, are performed in parallel on parallel processors, with each programmed conventionally, that is to say serially.

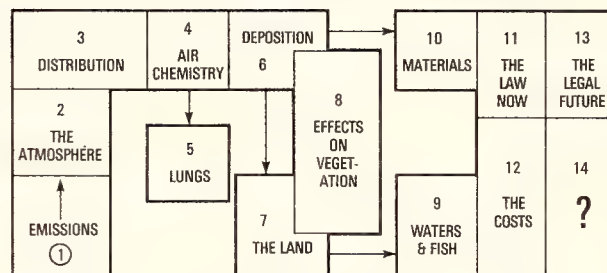
A possible alternative, called the "dataflow" architecture, is being investigated at Manchester and Newcastle universities and at Westfield College, London. Here, the program instructions are executed in parallel on a number of processors, but not necessarily in the order or sequence laid down by the program. Instead, they are executed when the data they need becomes available.

So, at the lowest level, dataflow programming languages include instructions like "WHENEVER" and "AS SOON AS" rather than the "DO THIS, THEN DO THAT" of conventional, or procedural languages, which force a particular order of execution. While it is clear that very powerful machines can be constructed on this principle, it is too early to tell whether they will ever be programmable.

For some heavy calculations, such as weather forecasting, the computation requires identical operations to be performed on a large set of data. For these problems, array processors, a special class of multiple processors, have been developed, such as ICL's distributed array processor (DAP). The DAP consists of an array of 64 by 64 very simple but fast one-bit processing elements, each with 2048 bits of local store. The DAP operates under the central control of an ICL 2900 mainframe computer, and can perform the same operations simultaneously on all the processing elements of its array. Hence it is ideally suited for calculations such as matrix inversion and Fourier transforms. As each of the operations proceeding in parallel are identical, special techniques or languages are unnecessary to handle synchronisation of simultaneous but different activities. (The DAP is programmed in a version of FORTRAN).

Present research on multiple microprocessors, apart from the design of special purpose systems such as DAP and C.VMP, is increasingly becoming less concerned with the problems of hardware and interconnection strategies. The cost of powerful microprocessors (hardware) will continue to fall over the next few years, while the cost of programming (software) is steadily increasing. One way to use the new technology successfully is to develop programming methods and software design techniques that are appropriate for multiple processor systems. □

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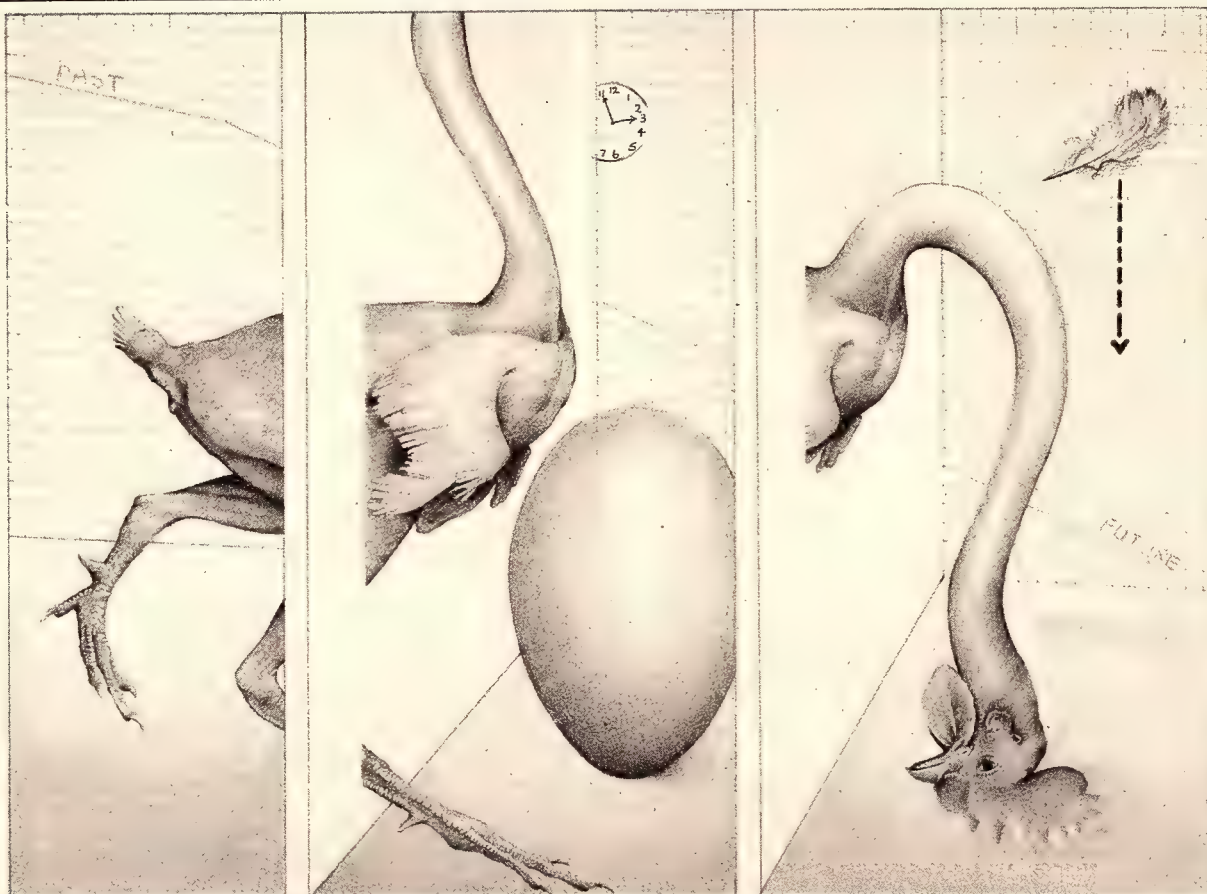
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Does gravity vary with time?

It is possible to set up a self-consistent view of the Universe by allowing G , the "constant of gravity", to vary over cosmological time.

Dr Vittorio M. Canuto

is with the NASA Goddard Institute for Space Studies and the City College of New York

Newton's intuition that the falling of an apple from a tree and the revolution of a small planet around a larger one are just two manifestations on different scales of the same physical law, led to the universal law of gravity, which states that between any two

objects of masses M_1 and M_2 , separated by a distance D , there acts an attractive force F_g proportional to the product of M_1 and M_2 and inversely proportional to the square of the distance D , $F_g = GM_1 M_2 / D^2$. The quantity G is called the gravitational constant. By qualifying G as a "constant", Newton meant that G does not depend on what is already explicitly written out, namely the masses and the distance. But is it possible that G varies with the age of the Universe? Is there a way to confirm or disprove this possibility using laboratory measurements? The answer to this last question is still negative.

In fact, among the fundamental constants that enter into many laws of physics, "big G " is the one that is the least accurately known. Its value is not known to a better accuracy than one part in ten thousand. On the other hand, a possible variation of G would be expected to have the age of the Universe (about 20 billion years, 2×10^{10} years) as a time scale, so its detection would require a laboratory measurement with a precision of 10^{-10} /year, something we do not command as yet. Unless we have measurements lasting one million years (10^6 years), in which case $(10^{-10}/\text{year}) \times 10^6 \text{ years} = 10^{-4}$, we cannot hope to find out if such a variation exists or not.

What are the arguments for or against? Neither Newton nor Einstein seems to have considered the possibility of variable G . Both adopted the point of view that G is constant in its widest sense, independent of everything, including time. In such a case G is just a constant whose measured value is 6.6732×10^{-8} dynes cm^2/gm^2 . Indeed, Einstein's equations of general relativity imply that G must be rigorously constant, once the law of conservation of energy is accepted; other relations derived from these equations, including Newton's equations, must carry the same imprint.

For example, the claim that G cannot vary inversely with time otherwise the Sun would have been unacceptably hot in the recent past, say two billion years ago, is unjustified. Such a conclusion is based on Newton's equations and the principle of conservation of energy; on accepting them, we also accept that G must be treated as a constant. This precludes the possibility of knowing what changes might have occurred to the Sun's luminosity if G were indeed greater in the past.

The unmatched success of Einstein's theory has led people to accept the constancy in time of G as well. This perfectly natural process is certainly not unscientific. Every theory is based on a certain number of hypotheses. Irrefutable confirmations of the predictions of the theory are by inference confirmation of the adequacy of the underlying hypothesis. The question of the variation of G seems therefore resolved with a clear answer: if Einstein says no, it must be no. But Einstein's theory may not be the end of the road.

The success of Einstein's theory is largely based on

experiments dealing with a portion of space-time, the Solar System, much smaller than the scales significantly affected by a possible variation of G . If such a variation existed, it would not have shown up as the primary effect when studying the Solar System: only very refined measurements or those made over long periods of time would reveal it. There may yet be a theory that reproduces the same basic results as Einstein's with respect to the Solar System, but which differs from it when larger time scales are involved, for example in cosmology. In much the same way while Newton's theory adequately explains the behaviour of everyday phenomena on Earth, we must turn to Einstein's theory when the detailed behaviour of the Solar System is investigated.

Even if G is a constant, what do we mean by the term "constant"? Take, for example, the fine structure constant, usually denoted by α , which characterises the strength of electromagnetic phenomena (see Box A). Its value is around $1/137$; α and G are quite different kinds of constant: α has no dimensions and so is a pure number, but G is not. If we change units, α remains the same, G does not. The numerical value of G quoted above is dependent on a particular system of units, dynes (to measure forces), cm (to measure lengths) and grams (to measure masses). G relates three separate physical properties, which are measured in different ways. Most crucially for the present discussion, G depends on how we measure time.

A. The fine structure constant

There are two kinds of constant in the world of physics, those which have dimensions and those which are dimensionless. In the equation $F = GM_1M_2/D^2$, which defines the constant of gravity G , in order for the two sides of the equation to balance G itself must have dimensions, which depend on the units used to measure F , the masses, and D . So the numerical value of G is different in different systems of units. In a similar way, although the speed of light is a universal constant, the number put on the constant is different in different systems of units— 3×10^{10} cm/s, or 186 000 miles/s, and so on.

One of the key constants in the world of atomic physics is the "fine structure constant", α , which is defined in terms of the charge on an electron (e), the speed of light (c) and Planck's constant (h), so that $\alpha = e^2/hc$.

This constant has a physical importance—it defines the so-called fine structure "splitting" of spectral lines. Yet, since the product hc has the same dimensions as e^2 , α itself has no dimensions, and is a pure number, $1/137.036$, in all systems of units. Clearly, in nature we already have evidence that some "constants" are more constant than others. J.G.

To measure time we need a clock—and nature provides us with at least two very different kinds of clock. Consider first two orbiting stars, large objects of masses M_1 and M_2 separated by a distance D , whose motion around one another is governed entirely by gravity, by the force F_g . The period of revolution P is given by Kepler's law, which also is expressible in terms of M , G and D . If we wait for one star to complete one revolution around the other, we shall have a unit of time. A second complete revolution will give us two units of time and so on. We have a clock—more precisely a time-marking device. Instead of two orbiting stars we can consider the Sun orbiting around the centre of the Galaxy, a trip that takes around 240 million years and which is referred to as a "cosmic year" (one cosmic year ago dinosaurs were roaming our planet!). These are examples of gravitational clocks. With macroscopic quantities like G , M and the velocity of light c , we can set up a perfectly acceptable system of units of mass, length and time.

But there is a second natural time-marking device, the atomic clock (see Box B). An atom is a microscopic entity whose dynamics are dictated by forces different from the ones acting on two orbiting stars. They are electric forces,

quite distinct from gravitational forces. They can be attractive as well as repulsive: gravitational forces are only attractive. Their strength is proportional to the product of the charges of the two objects and inversely proportional to the square of the distance that separates them. This force, $F_e = e_1 e_2 / D^2$, is called the Coulomb force.

B. Atomic clocks

The behaviour of individual atoms, and the interactions between individual atoms, depend entirely on electric and magnetic forces, since gravitational forces are far too feeble to play any part in the interactions of such tiny quantities of matter. Atoms emit or absorb electromagnetic energy at characteristic frequencies which correspond to certain well-defined changes in the possible energy states of the electrons in each atom; these frequencies are those of the spectral lines which can be used to identify any element uniquely.

But a frequency is simply a number of cycles per unit of time—per second, say. So for practical purposes we can choose to define one "second" as the time taken for a certain number of well-defined cycles to be completed. The atomic second is defined in this way as the time required for 9192 631 770 cycles of the radiation corresponding to a particular energy transition of the electrons in a caesium atom. This definition was chosen to agree with the definition of a second in terms of the rotation of the Earth; but it is in fact a quite independent measure derived entirely from electromagnetic interactions and having no links with gravity at all. Since January 1972, Atomic Time has been the basis of all timekeeping, including our radio time signals; because the rate of rotation of the Earth varies slightly, however, we now have occasional "leap seconds" introduced in our time signals.

This difference is caused by the irregular running of our gravitational "clock", the spinning Earth. But is there a more fundamental difference between atomic and gravitational time? J.G.

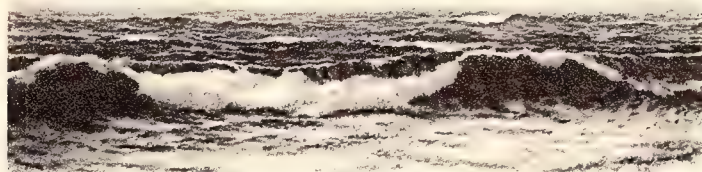
F_e and F_g depend on the distance D in exactly the same manner, for no obvious reason, but their strengths are very different. In a hydrogen atom (an electron orbiting a proton), the electric force F_e is 10^{40} times greater than F_g . This is good enough justification for physicists to neglect F_g whenever they study atoms, molecules, nuclei, and so on, and makes the atomic clock very different from the gravitational clock.

The units defined by atomic quantities are called "atomic units", in contrast to the gravitational or Einstein units defined by gravitational processes.

At first sight it might look as if the two units are just multiples of one another and nothing else: a trivial change of scale that would certainly not lead us anywhere but to a rescaling of all our quantities. This is not necessarily so, however. Since today's ratio of the two units is an enormously large number (10^{40}), the relevant question is: was F_e "created" to be 10^{40} times larger than F_g at the beginning of time or is it an accident of today? Nobody can answer that question since nobody was here billions of years ago to perform the necessary measurements.

If $F_e/F_g = 10^{40}$ has been the same since the beginning of the Universe, nature has only one clock (it does not matter what you call it) and Einstein's theory applies over the entire Universe, across all of time and space. But there are other possibilities. The ratio F_e/F_g is inversely proportional to G , so that any assumption about F_e/F_g is also an assumption about G ; and the main difference between F_e and F_g lies in their strength rather than their dependence on distance D .

Could it not be that the strengths that we now measure are such, simply because we measure them today and not, say, 10 billion years ago? Could it not be that the strengths were different in the past? This is perfectly possible and it would make more sense, I believe, for at least two reasons. First of all, the acceptance of an inherent differ-



ence in gravitational and atomic physics implies that the Universe was created thus and we shall never find out why. Yet there are other forces in nature besides F_g and F_e , namely the weak force and strong force of particle physics; this attitude would imply that the Universe was constructed with four different forces. Why four rather than five or sixty-four?

From one point of view, it makes more sense to think that in the beginning there was only one type of force, which, *because of the expansion of the Universe* broke into four different structures so that what we see today is nothing but a late manifestation of an initial unbroken symmetry of the forces. The broken symmetry we observe would therefore be ascribed to an ageing effect and not to an inborn property.

All the evidence we have points to the Universe as we know it "beginning" in a "big bang" and blasting outward from a state of very high energy density. So what do we know about the properties of matter at high energy states? When elementary particle experimenters probe the intimate structure of matter, they drive particles closer and closer together, using higher and higher energies and larger and costlier accelerators. Every time they perform such experiments, they genuinely reproduce a little bit of the Universe as it was billions of years ago—very energetic and hot.

The past few years of research in this field have witnessed a striking series of confirmations of a remarkable theory put forward 10 years ago by Steven Weinberg and Abdus Salam. This theory presents a framework under

which the electromagnetic and the weak forces become unified—at high enough energies the two forces merge into one. The Weinberg-Salam theory does not deal with gravity at all. But it does provide the first successful example of a unification of at least two forces. Before the advent of such a theory, the idea of unification was attractive but not compelling.

Now we are in a different position. Attempts at unifications are considered physically justified instead of just heroic pleas for something of which nature perhaps has not the slightest suspicion. Nature clearly has "thought about it", at least with electric and weak forces; she did not bother to invent one force for radioactivity and one for electricity. The branching is a later effect, a result of the decreasing energy density of the Universe.

Comforted by this example of good will and a wise sense of economy displayed by nature, it does not take much courage to generalise and think that gravity might have suffered the same fate. F_e and F_g may have been equal sometime back in the past. And that implies that long ago G must have been much larger than it is today.

Variable G and Einstein

Presented in this way, the logic of the argument in favour of "variable G cosmology" is clear. Remarkably, though, the idea was put forward more than 40 years ago, by Paul Dirac, long before the Weinberg-Salam theory. And Dirac has shown how variable G can be reconciled with the success of Einstein's equations of general relativity. Quite simply, according to Dirac, Einstein's equations in their original form are only valid when we use gravitational units. For example, if a star in a binary system whose motion is dictated solely by gravity were to perform experiments, it would find Einstein's equations applying precisely: and within this view of the Universe G would be a constant. But if a measuring device based on atomic clocks is used, then the situation may be quite different. In this respect we must remember that until 1955 all astronomical observations were recorded in terms of the time set by the Earth's motion round the Sun, because only one clock, a gravitational one, was available.

The question of variability of G depends on the system of units being used to make observations. How can we decide whether G "really" varies with time? From Einstein's or Newton's equations one can derive a very important result, namely that for a macroscopic object of mass M , the product GM must be constant. This is not a statement about G or M separately, but about their product. We have two unknowns, G and M , and one relation, $GM = \text{constant}$. In that sense the theory says nothing at all about G , which could have the craziest time dependence and still be perfectly acceptable as long as M is allowed to vary in the required (equally crazy) way.

Now if, for whatever good reason, we want to keep M constant (conserving energy, Mc^2) it then follows that G must be constant. This is the rule that was broken in all the analyses concerning the consequences of a varying G on the structure of the Sun, the motion of planets, cosmology etc, that have periodically appeared in the literature. After making extensive use of the principles of conservation of energy, the constraint $GM = \text{constant}$ was forgotten and G was allowed to vary in time, an illegal step that led to results in contradiction with observations, for instance concerning the past luminosity of the Sun. To read these results as indicating that G cannot vary in time instead of as a reprimand for having violated one of the basic rules, is not to read what the message really is.

Let me give an example. From Newtonian mechanics it follows that the distance of a planet from the Sun (call it R) and its period of revolution (call it P) are proportional to $(GM)^{-1}$ and $(GM)^{-3/2}$. Since $GM = \text{constant}$, both R and P are constants in time. It is incorrect to put at this point

$M = \text{constant}$, and conclude that R and P are proportional to G^{-1} and G^{-2} and to use these dependencies to put limits on the variability of G .

What happens if we let M and G vary in time so as to keep the constraint $GM = \text{constant}$ safely satisfied? This first step immediately runs into a big snag. Letting M vary with time means that energy is not conserved. Even disregarding the negative reaction that a physicist might rightfully have when told that one of the pillars of modern physics is crumbling, there is still an objectively more serious problem.

Are the first law of thermodynamics, Stefan's law (giving the density of radiation as a function of temperature), Maxwell's distribution function for particles with a given velocity and temperature, and so on, that are used when studying the Sun, compatible with the violation of energy conservation? They are not. All these relations, as we learned them in elementary physics, are based on that very principle which we have to relax if G is allowed to vary. What does that mean? It simply means that we find ourselves without a consistent scheme to operate with, and that borrowing standard thermodynamic relations is not correct.

Working with Drs S. H. Hsieh and P. J. Adams, (see *Physical Review D*, vol 16, p 1643, 1977), I have attempted to resolve this dilemma by looking at two types of Einstein equations: those with $GM = \text{constant}$, namely standard Einstein equations to be used only when we employ *gravitational* or *Einstein times*; and new ones, to be used when we employ *atomic times*, with respect to which G can vary even if M is constant. In these new units the product GM is no longer constant, opening the door to a completely new view of the Universe.

Consider an event, any event, that takes an amount of time Δt_E when measured with gravitational units and Δt when measured with the atomic units. The relation between the two can be written as $\Delta t_E = \beta(t) \Delta t$. What is $\beta(t)$? It is the epitome of our ignorance of how gravity might have changed with respect to atomic physics during the lifetime of the Universe.

Standard theory assumes that $\beta(t)$ is constant, independent of the age of the Universe. If nature is really endowed with only one clock, one should be able to *prove* it instead of *assuming* it, by formulating a theory that makes room for a non-constant but otherwise arbitrary $\beta(t)$, and by checking all available observational data. If the end results unequivocally show that only a constant β fits the bulk of the data, then we shall have performed a great service: indeed, we would have promoted to the category of a rigorously proven fact what used to be an assumption.

The new dynamic equations we have developed are valid for an *arbitrary* $\beta(t)$. When β is constant, the new

equations reduce to the standard ones just as Einstein's equations reduce to Newtonian mechanics.

We now have two relations: $G_E M_E = \text{constant}$ (where we have now added the index E to specify the Einstein units to which we refer), and $G_A M_A \beta = \text{constant}$ (where A indicates that we are referring to atomic units). Even with $M_A = \text{constant}$, G_A can still vary because of $\beta(t)$. The new theory has the built-in latitude needed to investigate the implications of a possible time variation of G .

How do these new equations change our view of the Universe? Even though we cannot go into the details of the mathematics, a physical description of the most important effects can nevertheless be attempted.

Einstein's equations tell us that the geometry of the Universe is uniquely determined by the amount of matter in it. Is this picture still rigorously true in our cosmology? Not entirely. The relationship between the amount of matter present today and the deceleration—the change in the velocity of expansion of the Universe—has changed. In fact, accelerations are defined as variations in time of velocities, and their values depend on which units of time we use. If we change our time unit from Δt_E to $\Delta t_A = \beta(t) \Delta t_E$, we are changing our metre stick as the Universe grows older. Atomic clocks continuously slow down or speed up (with respect to gravitational ones), depending on how $\beta(t)$ depends on time, which in turn implies that in interpreting gravitational effects with atomic clocks, we must make allowance for a “lens effect” due to $\beta(t)$, an effect which can either magnify or reduce.

As an example, let us suppose that $\beta(t)$ increases with time in a simple way, proportional to t , and that $\beta(t)$ is unity today. What happens to the radius of the Universe, and its rate of change (also known as the Hubble constant)?

A new relativity of time

If we call the radius when referred to gravitational and atomic clocks R_E and R_A , respectively, we shall have $R_E = \beta R_A$. If $\beta < 1$, it follows that R_A must have been larger than R_E , if we want them to coincide today. All our observations of the Universe made with light from distant galaxies show things as they used to be, so we “see” R_A bigger than R_E . This is an example of magnification.

But since R_E was smaller than R_A in the past and is equal to R_A today, it must have grown faster than R_A , so that its rate of change must be greater than that of R_A . The Hubble constant with respect to atomic time is less than that referred to gravitational time. The age of the Universe is therefore greater when recorded with atomic clocks than when recorded with gravitational clocks.

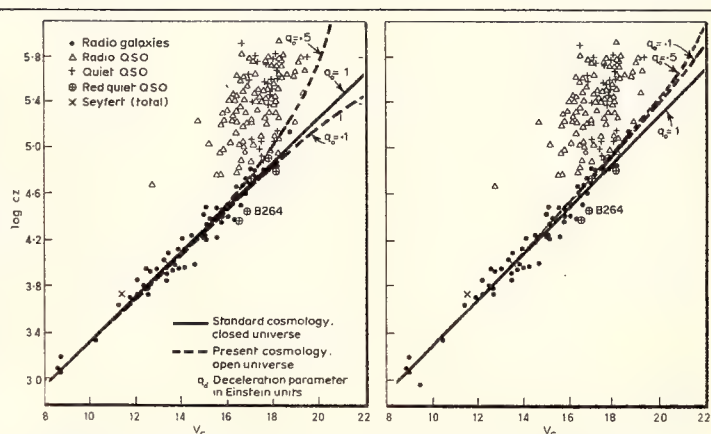
We have, so to speak, introduced a new relativity of time over and above the one discussed by Einstein. On measuring the same phenomenon, clocks can yield different

C. Observational tests

One of the most important observations in cosmology is the “3 K” background radiation, the echo of the “big bang” itself. This is explained in exactly the same way in the variable G cosmology as in standard cosmology for any $\beta(t)$. But other tests depend on the nature of $\beta(t)$. We can, for example, study the “red-shift” of galaxies due to their recession from Earth as the Universe expands. Such tests have been made by Canuto in collaboration with Jane Owen and S. H. Hsieh. The results have been published in a series of papers in *Astrophysical Journal*.

If $\beta(t)$ is increasing, the observations of the luminosities of distant galaxies (see figure) imply that the Universe must be “open” (see *New Scientist*, p 757, 8 March 1979). A better fit than that given by standard cosmology between theory and observations is then obtained.

Alternatively, if $\beta(t)$ is decreasing, there is no clear indication of whether the Universe is open or closed—exactly the same situation as in standard cosmology. J.G.



Variation of red-shift (log cz) with apparent visual magnitude (V_c) if $\beta(t)$ increases (left), or $\beta(t)$ decreases (right)

results not only when they move with respect to each other (Einstein's relativity), but also if they are in different epochs in the evolution of the Universe.

The predictions of the new theory have *never* been found to contradict the standard cosmological tests (for example, luminosities, radio fluxes and angular sizes of galaxies and quasars: see Box C). But to establish unambiguously that $\beta(t)$ is indispensable, we must come back to the Solar System and the motions of the planets.

The distances, R , of planets from the Sun are determined by gravity, and must transform like times, so $R_E = \beta(t) R(t)$. Since R_E is constant, it follows that if β is not constant, $R(t)$ cannot be either. The planet must either approach or go further away from the Sun, depending on whether $\beta(t)$ increases or decreases with time. If we can establish observationally that the planet's distance does change in time, we then have the conclusive confirmation that β is not a constant. It would be a clear "yes" or "no" answer.

Taking the age of the Universe to be 20 billion years, our theory predicts a rate of change of the distance of Mars of about 14 feet per year, either toward or away from us. This phenomenon is being studied by Irwin I. Shapiro and Robert D. Reasenberg at MIT. In addition, the distance of the Moon is being measured in laser-ranging experiments by researchers at McDonald Observatory and the Jet Propulsion Laboratories (JPL).

Another handle on the problem is provided by the rate at which the Moon picks up the angular momentum lost by the Earth, due to tidal effects. The Moon's distance from us increases and so does its period. Paul Muller of JPL has analysed ancient eclipses of the Sun (based on "ephemeris", or gravitational time) going back more than 2000 years. He concludes that the change in time of the Moon's angular velocity amounts to -30 ± 3 , seconds of

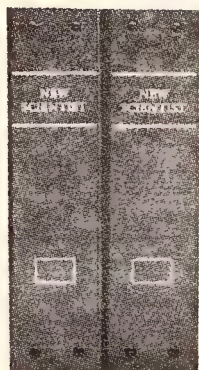
arc per century per century. (Correspondingly, the Moon-to-Earth distance increases by 4.6 cm per year.)

But during 1978, Odile Calame and Derral Mulholland of McDonald Observatory, Thomas Van Flandern of the US Naval Observatory and James Williams, William Sinclair and Charles Yoder of JPL presented results of measurements of the change in time of the Moon's angular velocity using atomic clocks and their values are -24.6 ± 1.6 ; -21.7 ± 3.6 and -23.9 ± 4 , respectively, where the units are the same as before.

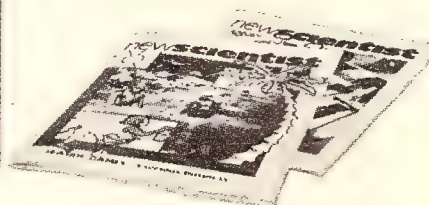
These numbers, comfortably similar to one another, are different from Muller's. Since the atomic result is less negative than the gravitational one, atomic clocks are picking up some extra positive contribution. If so, β cannot be constant: it must be an increasing function of time.

From the relation $G_A M_A \beta = \text{constant}$, and $M_A = \text{constant}$, it then follows that if $\beta(t)$ is increasing with time, G_A must be decreasing. If so, we would have proven that gravity is not constant in time. It would be very nice if the arguments were indeed so straightforward. Unfortunately, they are not. Large errors still plague the measurements and no conclusive statement can therefore be made concerning $\beta(t)$ or $G(t)$. It could be that the single "correct" answer for the Moon's gain in momentum is -27 , just on the edge of the limits of error for the different types of observation. We do not wish to overplay the results.

Purely gravitational experiments clearly hold the key to the solution of the problem and while we have to admit that even after many years we cannot close the books with a conclusive answer, it is nevertheless rewarding to realise that the somewhat isolated question of the variation of G has matured through the years to become an integral part of the quest for the unification of the four forces of physics. □



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Just for the fun of it

Rational and animal

Philosophers commonly imagine man to be wholly different from other animals, by virtue of his rationality. Biology, married to philosophy, presents a different view

Mary Midgley

is senior lecturer in philosophy, Newcastle University

I am trying to come to grips with the question, what is it, essentially, that we so respect about rationality? What is so good about it?

Why, for instance, does Immanuel

Kant sound convincing when he suggests that it is the *only* thing that can command respect? We would not be likely to take this view of mere cleverness. Indeed there is a sense, though a boring one, in which computers can be clever, but only people very deeply misguided and prone to the pathetic fallacy could respect them.

There are, I think, two distinct elements in rationality: cleverness and integration. By integration I mean having a character, acting as a whole, having a firm and effective priority system. The second is a condition of the first, not the other way round. For the full respect that we give to rationality, we need both. But integration alone is something of enormous value, and respect seems a suitable name for the recognition with which we salute it. And integration is not confined to people.

In Niko Tinbergen's book, *The Herring Gull's World*, there are two especially instructive illustrations. One shows a gull reposing, eyes closed and wings folded, the picture of fatuous parental contentment, on an empty nest, while its eggs addle in the cold, a foot away. Helpful ethologists have removed the eggs to see which the creature would prefer, and it has settled for the nest. The other, still more remarkable, shows an oyster catcher trying to perch on top of a monstrous egg, larger than itself, ignoring its own egg and a rather larger gull's egg that is there for further choice. The large egg, a dummy, has been provided by the ethologists to test the bird's powers of discrimination. These are two of many examples where interference has shown how slight, how easily garbled, are the natural cues creatures act on, even in cases essential to survival. Herring gulls, it seems, care more about nests than eggs; oyster catchers like their eggs substantial. And these preferences do no harm in the normal situation where

there are no experimenters around, for normally the eggs stay in the nest, and all available eggs are roughly the same size. So there has been no selection pressure to alert gulls about roving eggs, nor to control the romantic dream, which oyster catchers apparently cherish in their hearts, of one day finding an egg really worth sitting on.

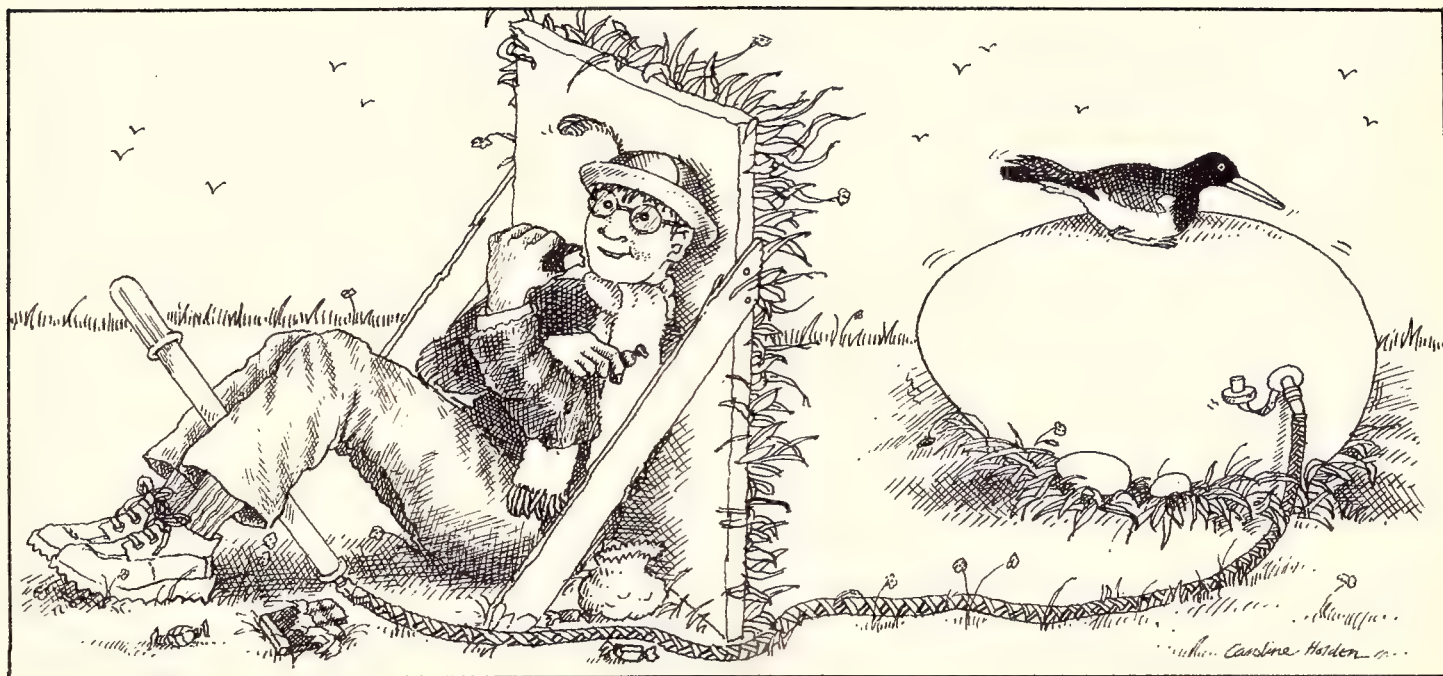
Things like outsize eggs are called supernormal stimuli. In these cases, the creature wants what it needs, but wants much *more* of it than it needs—has, in fact, not the slightest idea when to stop. Unlike over-eating, which brings on discomfort, or over-sleeping, which is broken off naturally, tastes such as outsize-egg-hunger have no built-in corrective. In these situations, tastes depend for their regulation on outside circumstances, which in the course of evolution plainly did not often fail. Their owners simply have no way of knowing when they have had enough of a good thing.

This is sad, we think, and bizarre, but, naturally, nothing to do with *Homo sapiens*.

But isn't it? Might not a species that cannot stop stuffing itself with chocolates, drinking spirits, racing fast cars, gambling, wasting resources, competing, fighting, and watching Miss World on television have something to learn from that unlucky gull and oyster catcher?

Chocolates are an interesting example. A taste for sweetness has some selective values for fruit eaters, because it leads a creature to prefer ripe but not rotten fruit. And of course, in the wild, other sweet things are rare, so no firm safety-stop on sweetness is necessary. This is why, given a supply of sugar, human teeth and human figures are in such danger.

Obsessiveness unbalances people's tastes against biological advantage. In no species do instincts form a perfectly balanced, infallible set, a smooth machine, such as human envy supposes animals to have. Miss World adds an extra twist to this unbalance, in that she is, so to speak, purely visual and speculative, possessing no practical or tactile components. She is doubly abstracted. Voyeurism



does not lead anywhere. But this is no different, in principle, from the gull's problem. There is, I think, a characteristic feeling of *exasperation* about these partial stimuli—a feeling of being dragged apart. One side of us has been worked on separately and roused to a feeling that excludes the rest. And our nature fits us to operate as a whole.

We may, of course, deal with this conflict by clamping down sharply on the competing interests, or by trying to make one of them prevail. But one way or another we must try to deal with it, because, unlike the gull and the oyster catcher, *we can see what is going on*, though we often find that we cannot do anything about it. The exasperation is even sharper in a way when the stimuli seem petty and isolated, but still irresistible. Recently I read two furious letters to the newspaper from people wanting particular petty stimuli banned—one a smoker objecting to cigarette advertising, the other a supermarket customer objecting to candy piled at the checkout counter. Both writers said quite honestly that it was not just the simple peasantry they wanted to protect, but themselves. And I think what they wanted protection against was *fragmentation*, not just the ill consequences of smoking or eating candy. ("How dare you set me against myself?") Perhaps this is the basic objection to advertising generally, and indeed to the whole overstimulating surface of our cities—"stop setting me in conflict".

Mentally ensnared

Such internal conflict is always confusing, disquieting, and somehow sinister. We are trapped on one side; we cannot pull free. (Supernormal stimuli are, of course, typically the kind of thing used to *bait traps*.) We feel that our nature demands that we should be able to extricate ourselves, to understand what is going on within us and either endorse or control it. We feel that it demands integration.

Does this feeling make biological sense?

Bishop Joseph Butler, the renowned moral philosopher of the early 18th century, puts the problem thus:

Suppose a brute creature by any bait to be allured into a snare, by which he is destroyed. He plainly followed the bent of his nature, leading him to gratify his appetite; there is an entire correspondence between his whole nature and such an action; such action therefore is natural. But suppose a man, foreseeing the same danger of certain ruin, should rush into it for the sake of a present gratification; he in this instance would follow his strongest desire, as did the brute creature; but there would be as manifest a disproportion between the nature of man and such an action, as between the meanest work of art and the skill of the greatest master of that art—Which disproportion arises, not from considering the action singly in itself, or in its consequences, but from comparison of it with the nature of the agent. And since such an action is utterly disproportionate to the nature of man, it is in the strictest and most proper sense unnatural.

About people, Butler is surely right. If a person who had his memory and his intelligence did not *mind* traps, if he had no centre, no policy, if he drifted from act to act without any attempt at continuity or interest in relating them, people in any culture would say that he had something wrong with him. We ourselves would probably say there was something medically wrong; we might put it that he was *not all there*. And we would certainly be likely to call him irrational. Sophisticated "policies of not having a policy" are no exception. If they have some guiding principle, they are only partial; if they really have none, anything can happen. A policy of being flexible on certain selected issues is still a policy; there must be constants elsewhere to call for it. Integration of the personality is not just an optional extra. It is a need. Human beings must have a structure, a policy, a continuity. Each has only one



D^o JOSEPH BUTLER.
Bishop of Durham.

Mary Evans Picture Library

life to live. He cannot split up as a coral colony might, into several 'hatches' of polyps, each equipped to go their separate ways. Without a lasting character, he cannot even follow out a train of thought—which is why I say that this is a condition of intelligence, not vice versa. Complete disintegration, then, is hard to imagine. But partial cases are very common. Most of us have personalities fairly well integrated on one side, the side we attend to, but fragmented on others, to which we pay less attention.

Butler's idea is that if we reflect on our own nature, if we attend to our neglected outlying motives and relate them to the centre, we shall be able to judge them—because the reflective centre of our personality has a natural authority, is in a position to judge. "Had it strength, as it has right, had it force, as it has manifest authority, it would absolutely govern the world." It "demands in all cases to govern such a creature as man".

Butler calls it conscience, not reason, and this has made some people miss his meaning, because they personify "conscience", even more simply and disastrously than "reason", and see it merely as the voice of prejudice, an irresponsible despot. Butler, however, carefully avoids the errors of personifying. He repeatedly explains that he does *not* mean by conscience any unaccountable oracle or intuition, but a reflective faculty at the centre of ourselves, by which we can think about our various actions and desires, stamping some with approval and rejecting others. And of course he does not make the mistake of personifying faculties either. For him, conscience (or reflection) is simply the man himself in his capacity as decider—each of us, when we think seriously what we are for and against.

By reflecting, Butler says, we stumble on the moral law, because that is the law of our own nature. "Your obligation to obey this law is, its being the law of your nature." It is not imposed from without. It is "the most intimate of all obligations; and which a man cannot transgress without being self-condemned, and unless he has corrupted his nature, without real self-dislike". He repeatedly points out that it does not depend on any religious sanctions, because it is more fundamental than they. It is as binding on pagans and unbelievers as it is on Christians. "Man is thus by his very nature a law to himself."

People are alarmed when Butler speaks of the "absolute authority" of conscience or reflection over other motives, because they smell political despotism. Now if Butler had meant by conscience what some people mean by it—prejudice, egoism, or fancy—he would, of course, have been cutting short reflection before it could begin. But he means reflection itself. In a full discussion of self-deception, he makes it clear how wrong it is to distort the term conscience by using it to set up any such private oracle. What Butler intends is quite different. He is saying that reflection demands action. To put it philosophically, he is pointing out the peculiar "prescriptive" form in which the conclusions of practical thinking emerge. They are not just theoretical and informative, but imperative and practical as well. If your night's reflection makes clear to you that in your inmost being you loathe and reject the corruption of the city council, then there will follow particular commands—like "refuse that bribe". And this command cannot be treated just as one motive among others, a mere impulse to refusal, competing on even terms with other

impulses and winning or losing according to its force at the moment.

To put the point more psychologically, Butler is pointing out the dangers of a confused personality, remarking that the price of ignoring one's centre or refusing to reflect properly is disintegration. In his sermon "Upon the Character of Balaam", he looks at the case of a self-deceiving religious obsessive, carefully keeping to the letter of his duty while he violates the spirit of it. This man, he points out, has failed in reflection quite as much as any corrupt contractor. He is deeply disorganised; he is refusing to know what he is about. Butler discusses this phenomenon of self-deception in the next sermon, and finally breaks out: "If people will be wicked, they had better of the two be so from the common vicious passions without such refinements, than from this deep and calm source of delusion, which undermines the whole principle of good; darkens that light, the *candle of the Lord within*, which is to direct our step, and corrupts conscience, which is the guide of life."

The distinctive thing about Butler is his insistence that it is our emotional constitution that gives us the material to reflect on. We begin to see how it is not ridiculous to suppose that we evolved as the kind of creatures that we are. In explaining the work of conscience, Butler's argument indeed is throughout thoroughly biological. It rests on *function*. He asks, what *use* is the conscience? He starts from what he calls a fact, namely the human tendency to reflect on our own and each other's conduct, to judge it, to accuse and excuse ourselves and other people, and to feel *shame* when we ourselves fall short. Shame particularly interests him; he asks quite simply, what is its function? And he notes the great force of such functional arguments in general: "A man can as little doubt whether his eyes were given him to see with, as he can doubt the truth of the science of optics, deduced from ocular experiments. And allowing the inward feeling, shame, a man can as little doubt whether it was given him to prevent his doing shameful actions, as he can doubt whether his eyes were given him to guide his steps." The capacity for shame, therefore, is a part of our adaptation as social beings. Putting this question is like asking, why does this creature have legs? If the only intelligible answer is "to get around with", it follows that the creature is *designed, adapted or programmed* to get around; that a stationary life will not suit it, indeed will be bad for it, if only by being a waste of this important resource. Just so with the human capacity for shame and also more generally with the power of reflection—their use is practical. They are fairly central parts of us—not a peripheral one like the appendix or the kiwi's wings. So trying to ignore them will be at best wasteful and probably destructive. So they ought to be used. And in the case of conscience or reflection, Butler suggests, the argument is especially strong, because the position it seems designed for is such a central one. Outlying faculties, if neglected, might atrophy quietly, but, as he says, "you cannot form a notion of this faculty, conscience, without taking in judgement, direction, superintendency". Bypassing such a central nexus would be something like deciding to dispense with the central nervous system. Psychosurgery is out of place here.

Butler's contrast between man and animal, however, is too simple because animals have frames of reference as well. They are not just bundles of disconnected perceptions and motives. They have natures of their own, each according to their species. And actions, which can very well take place, can all the same be contrary to those natures.

Butler's example of the snare is not, in fact, especially typical of animal behaviour, at least above the insect level. (It is worth noting that both the snare situation and those of the poor deluded gull and oyster catcher result from human interference, not from conditions normal to the

species.) Animals that respond to a supernormal stimulus are indeed somewhat passive. But then, so are people who do so. The single stimulus drives it to a single, easily predicted piece of behaviour. If the whole life of other species were like this and human life never was, the contrast would be fair. But it is not. Actually, as pest control people know all too well, animals can very often resist traps. Their natures are quite equal to the effort. Human beings, on the other hand, quite often do fall into traps, not only into those laid by other human beings, but even those laid by animals, as for instance when a wounded rhinoceros circles round to lie in wait on its own trail and charge the hunter who is following it, or a man-eating lion ambushes jungle paths.

Complex social ties

Every species has its own characteristic temperament, of which systematic caution is often a part. We could take any stretch of the lively social goings-on watched by George Schaller or Jane Goodall. Here each species busies itself according to taste—the quiet, dignified gorillas foraging and exchanging greetings, the lively volatile, outgoing chimps exploring and holding parties. Each member has complex social ties, and develops them according to its character; the conventions are well understood, and action contrary to the nature either of the individual or the species can be easily spotted by the experienced observer. It shows up as something *wrong*.

Again, consider the well-organised wolves. Cub care is *important* to wolves. So is affection for their friends and companions. (Indeed the two things go together; the gestures by which adults show affection are drawn from cub-rearing.) Affection is a prevailing motive. Powerful general motives like this can easily make them delay gratification of immediate desires like hunger or sleepiness. The whole pack is bound together by affection. But this affection too is not "blind impulse"; it has a *backbone*, a structure that keeps it steady through variations of mood. All wolves have claims, which are generally recognised. And a cross or bored wolf will not just bite another; he quarrels, but he gives warning in a set and intelligible manner. Threats express his irritation; the opponent has time to get out or submit. And submission usually disarms the aggressor. A very interesting thing is that at this point a conflict of motives may be visible; one motive does not necessarily replace another smoothly and unremarked. There is *ambivalence*, conflict behaviour. The dominant one refrains from biting, but still growls and snaps over his prostrate enemy, making biting and shaking movements; he won't let the loser get up for a while; when he does get up, he chases him away. Both motives are present together; the wolf is in a way identified with both, yet he must choose one for action. We have all done this. It is surely the kind of situation out of which a real centre to the personality emerges. The choice we make determines the sort of person we are becoming.

We tend to think of animals as not having this problem. They do have the problem. What they do not have is our way of solving it by thinking about it. But they still have a way of solving it—namely, by a structure of motives that shapes their lives around a **certain preferred** kind of solution. If we did not have that too, thinking would get us nowhere.

My point is not just that intelligence, as it develops, is applied to these emotional conflicts. It develops partly as an adaptation to deal with them, for they are quite as serious a threat to life as hunger is, and more serious than the lack of tools. Emotional stability, a solid, continuous character, is necessary to survival. It is quite as necessary as technology, and indeed technology depends on it. □

Monitor

Space is lonelier than we thought

Estimates made in recent years predicting that up to a million advanced civilisations inhabit the Milky Way galaxy may have to be drastically revised. A study of the continuously habitable zones about various types of central star suggests that far fewer planets than previously thought have conditions suitable for life to evolve (*Icarus*, vol 37, p 351).

Dr Michael Hart of the Systems and Applied Sciences Corporation, in Maryland, has extended to other stars his earlier study of the evolution of conditions on the Earth through the Sun's lifetime (*New Scientist*, vol 78, p 668). He demonstrated then that life only just managed to exist on Earth: had the Earth's orbit been just five per cent closer to the Sun, a runaway greenhouse effect 3.7 billion years ago would have produced a Venus-like planet. Had the orbit been just 1 per cent farther away, runaway glaciation 1.7 billion years ago would have produced a Mars-like planet.

Now Hart has shown that the same applies to planets surrounding many stars. Estimates of the number of planets where life has evolved have been based on the assumption that life would develop and evolve on any suitable planet where liquid water existed on some part of the surface. But Hart says that runaway greenhouse and glaciation limitations



drastically reduce the zone of continuous habitability—the regions where conditions are sufficiently benign during the three to four billion years needed for the emergence of advanced life forms. Smaller, less luminous stars than the Sun have a narrower, closer life zone, but this rapidly shrinks down to zero for a typical K1 star with a mass of 0.83 Suns—so there is no habitable zone around

most K or M class stars.

The life zone is wider and more distant for stars with masses greater than the Sun but those with even a modest 10 per cent increase in mass would emit enough ultraviolet light after four billion years to severely hamper the spread of life onto dry land. In addition, above 1.2 solar masses, planets which avoid runaway glaciation after 3.5 billion years were too hot at 400 000 years.

Hart concludes that only stars between 0.8 and 1.2 solar masses are real candidates for advanced life forms; and not all of these would necessarily have a terrestrial type planet orbiting in the few million kilometre wide zone of continuous habitability. We may not be alone, but we clearly do not have as much company as we would have liked. □

Less muscle in muscular dystrophy?

A hope for a cure for muscular dystrophy—a crippling genetic disease which attacks young boys—has emerged from a successful attempt to isolate a protein that slows down muscle synthesis. The muscles of dystrophy sufferers waste away; and the usual treatment, constant supportive physiotherapy, is not enough to prevent paralysis and early death.

Many causes have been put forward

to explain the commonest variety, Duchenne dystrophy. One is an increase in the rate of the destruction of muscle in the normal tissue renewal process, and another is that the new tissue is not being made fast enough. Ray Petryshyn and McEwan Nicholls at Toronto University have been looking for a chemical that inhibits tissue creation (*Biochemical Journal*, vol 176, p 907).

Proteins are synthesised in many stages—an amino acid is bound to a transfer molecule (tRNA); then this complex is incorporated into a ribosome. The ribosome “reads” a messenger RNA and inserts the correct amino acid into a growing protein chain, according to the code in the messenger. The protein is a “translation” of the messenger. Among the many proteins involved in the control of this process are two regulatory elongation factors, EF1 and EF2. Might there be, by analogy, protein inhibitory factors, and perhaps more of them in dystrophic muscle? It rather looks as if this is the case.

When isolated, the inhibitor was found to be a large molecule that slowed down protein synthesis in preparations of normal muscle. Its activity was not destroyed by enzymes which degrade RNA, DNA or phospholipids; but pronase, which attacks protein, did the trick. So the inhibitor is probably a large protein (about the size of haemoglobin).

The inhibitory factor may have a natural function but be grossly exaggerated in this genetic disease (and genes, after all, only make proteins). There are instances where protein synthesis is shut down, and cells stay dormant. And here too inhibitors have been found but not characterised.

Is the human disease in any way similar? Do Duchenne-dystrophic boys synthesise less muscle protein? We have known for about eight years that they do. Do the inhibitors exist in their muscles? If so, perhaps we can cure them. □

Movie highlights cell killing

Cytotoxic T cells, the “killer” lymphocytes of the immune system, may not kill the cells they are designed to destroy by a direct action on the cell membrane. This finding, which goes somewhat against some of the previous hypotheses of lymphocyte killing tactics, comes from the pharmaceutical research department of the drug company, Hoffman la Roche in Basle, Switzerland. (*Immunology*, vol 36, p 178).

Foreign invaders to the body stimulate into action the lymphocytes of the immune system, which then engage in a variety of activities aimed at destroying the invader. Cells of one population—the B cells—secrete protein antibodies tailor made to bind onto the particular invader. Cells of another group—T cells—perform a larger number of roles. Some help B cells to produce antibodies, some suppress the same function; but one group, the cytotoxic T cells, are the “hit-men” of the immune system.

When properly programmed, these cells wander off into the circulation with a target cell type firmly printed on their surface receptors. When they find it, they kill it. Though many examples of this cell-mediated immunity are well documented, we still don't know just how these efficient little killers dispatch their targets.

A. Matter, decided to film this interaction between these killer lymphocytes

and their targets using micro-cinematography, and combined his study with an electron microscope analysis of each piece of the action.

He first raised a population of the cytotoxic T cells, primed to kill malignant tumour cells which were then used as the targets. The cells were mixed, and the cameras rolled. The film showed that the interaction always followed a similar pattern. First came the recognition phase, in which the T cell crawls at random over the target: then the cell membranes of the two combatants come into very close contact. Suddenly the target-cell membrane begins to bulge out irregularly, and at this stage it is effectively dead.

Because of the very close contact between the membranes, many previous workers have suggested that the membrane disruption is the direct cause of the target cells death. However, the electron microscope pictures made in this study seem to show that the blistering of the surface membrane coincides with catastrophic disruptions within the cell, involving the nucleus, mitochondria and other organelles of the target cell. This suggests that the message to “self-destruct” may well come from within the target cell, triggered by a secretion or physical action of the T-cell sitting on its surface.

We still don't know of course what this trigger is, and we can't yet rule out the possibility that it is the disruption of the target's surface that triggers the cell's suicide, even though this may not be the final cause of death. □

Grouse song swings low

Grouse are the first land animals to be caught "broadcasting" infrasound—vibrations of the air at lower frequencies than humans can perceive. Whales probably keep in touch over hundreds of kilometres of ocean via these ultralow frequency (ULF) sounds—now recent work on the vocalisation of the capercaillie (*Tetrao urogallus*), the largest member of the grouse family, suggests that they too use this part of the sound spectrum.

R. Moss, of the Institute of Terrestrial Ecology at Banchory, and I. Lockie, of Robert Gordon's Institute of Technology in Aberdeen, have pooled their ornithological and physics expertise and recorded and spectrographically analysed the "song" of the male capercaillie (*Ibis*, vol 121, p 95). This song, which is heard in spring on the breeding grounds in the conifer woods of Scotland, is remarkable for two reasons; its very low volume (barely audible for humans at a distance of 200 m) and the peculiar sound sequence.

This sequence has been described as that of the sound of two sticks being knocked together, followed without a break by a sound like the drawing of a champagne cork and ending with a sound like the grinding of a knife! The low volume is surprising as the capercaillie is very large, weighing up to 4 kg.

With its extra large oesophagus, which balloons like an amplifying chamber when it sings, the bird should be able to produce a high volume of sound. In addition, the capercaillie is polygamous, and males, like other grouse species with similar mating habits, would be expected to produce loud songs to attract females from as far away as possible.

With great fortitude Moss and Lockie recorded the song of a "tame" male which persistently attacked both them and their microphone, which they endeavoured to hold 10 cm from the animal's throat. Spectrographic and sound-level analysis revealed a large infrasonic component with sound levels of nearly 60 dB at frequencies as low as 16 Hz—well below the range of human hearing.

Moss and Lockie are not yet sure whether the capercaillie uses these low frequency sounds for communication. There is certainly some advantage in using ULF sounds in communication. The absorption of sound in air decreases with frequency and so these infrasonic sounds of the capercaillie will travel much longer distances than those of similar intensity at higher, more conventional, bird-song frequencies—and so attract prospective mates from a wider area. On the other hand, the lower the fre-



Male capercaillie on display

quency, the longer it takes to transmit information.

Experts will look forward to finding out whether other grouse species and even the smaller female capercaillie also have infrasonic components in their songs, or whether it is only the extra large male capercaillie that is capable of these "deep throat" noises. □

The southern crab

A collaborative search for astronomers from the UK and Holland has come up with a supernova remnant very similar to the Crab Nebula, once thought to be unique in its properties. Using the 1 metre UK Schmidt telescope to locate the nebula and the 3.9 metre Anglo-Australian telescope to subject it to detailed study, they have found that the source, named G292.0+1.8, is brighter in the centre than at the edges, and its matter is travelling at high velocities and its spectra show similar anomalies. On deep photographic plates, it appears as a diffuse, faint arc of emission near the centre of the remnant. When it comes to its optical spectral properties, however, the new remnant really holds its own with its more illustrious northern counterpart. The work will be published shortly in *Monthly Notices of the Royal Society*.

One of the most precious jewels in the northern heavens is the Crab Nebula—the entangled web of high-velocity debris from the stellar explosion (supernova) witnessed on Earth in the year AD 1054. Long thought to be unique among supernova remnants, the Crab has played a dominant part in high-energy astrophysics—a larger fraction of the new power of modern astronomy has been focused on the Crab Nebula and its pulsar than any other object.

However, in recent years six or more supernova remnants discovered in the Galaxy have been likened to the Crab, at least in terms of their properties at

radio wavelengths. The vast majority of supernova remnants show peak radio brightness around their periphery, with the intensity of emission falling off markedly with increasing frequency.

The Crab-like remnants, on the other hand, are brightest near their centres, with a slowly decreasing intensity with increasing frequency. Previously only one of the new Crab-like remnants had also been identified at optical wavelengths—an object called 3C58, the probable remnant of the supernova witnessed in the Far East in AD 1181. However, while similar to the Crab at radio wave-

Stress on sweat

People sweat either because of heat or emotional stress. Older physiology textbooks will tell you that thermal sweating occurs over all the body—except the palms of the hands and soles of the feet, these being the areas that predominate in mental sweating.

However, these notions have been questioned by Dr Judith Allen and colleagues at Queen's University, Belfast. In 1973, they showed that sweat glands of all regions of the body responded to the stress of doing mental arithmetic, and have now shown that a 6°C rise in air temperature—from 29°C to 35°C—increases the rate of water loss from the palms and soles (including the respective fingers and toes) by over four times (*Journal of Physiology*, vol 285, p 35P).

Clammy hands, it seems, are not all in the mind. And counting blossoms out all over. □

lengths, the optical remnant of 3C58 resembled the Crab not at all. The optical material in 3C58 is faint, of low velocity, diffuse, and shows none of the spectral peculiarities of the Crab. What one is seeing in 3C58 is illuminated interstellar material, rather than ejecta from the supernova of AD 1181.

W. Zealey, P. Murdin, D. Clark, from the UK, and M. Goss and P. Shaver from Holland found that the optical radiating material from G292.0+1.8 is expanding from the site of the supernova outburst with velocities up to 1500 kilometres per second, comparable with the largest velocities measured in the Crab Nebula. The spectrum of the high-velocity material shows that it is mainly oxygen and neon, formed at an advanced stage of the evolution of the progenitor star and blasted into space in the supernova explosion. For only two other Galactic supernova remnants has ejecta from the supernova outburst been identified—the Crab Nebula, and the young remnant Cassiopeia A. The high velocities and small diameter of G292.0+1.8 argue for it being formed in a comparatively recent supernova explosion, possibly within the past millenium. Lying in a fairly clear region the supernova should have been bright enough at maximum light to outshine even Venus. It was too far south, however, to have been recorded by northern hemisphere civilisations with their written histories. Only star gazers at southern latitudes could have witnessed this spectacular display of celestial pyrotechnics. □

Monitor

continued

Sun retarded by dusty optics

The different measures of the Sun's rotation that have plagued solar physicists for decades are due not to the peculiar physics of the Sun but to light scattering by dust on telescope mirrors and lenses. Astronomers working at the Solar Observatory at Stanford University have come to this conclusion after making observations through a telescope whose objective lens they had deliberately covered with dust.

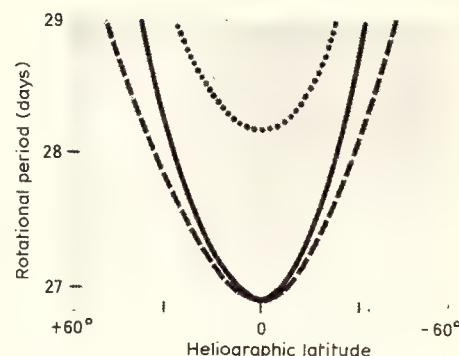
There are many possible measures of rotation corresponding to different heights in the solar atmosphere, but they all boil down to two basic techniques—tracers and doppler shifts—and rotation rates derived from the latter are consistently lower. "Tracers" signify any features which can be traced through at least a substantial fraction of a solar rotation period; sunspots, filaments, magnetic regions, and features of the corona all qualify. Sunspots are the classic photospheric tracers and, so long as their size and shape do not change too rapidly, their motion across the solar disc reveals a sidereal rate of rotation of 14.45 degrees per day at the Equator, or equivalently 2.03 km/s. The other way is to measure the relative doppler shifts of absorption lines across the face of the Sun, from the blue shift of the approaching east limb to the red shift of the receding west limb. At the Equator, the rotation rate was found to be 13.76 degrees per day, or 1.93 km/s.

Solar physicists have exerted themselves to show that this discrepancy has a genuine physical basis, that it reflects the mass motion of sunspots through the local photospheric plasma at a greater rate than the bulk solar rotation but in the same direction. Two theories accounting for the different periods were advanced in 1972. One suggested that sunspots and other regions of higher

magnetic field are anchored through their greater magnetic energy density to a subphotospheric layer rotating faster than the surface. It is true that from magnetic charts one can infer much the same rotation rate as for current sunspots, both up to 5 per cent faster than the apparent doppler motions (see Figure). The other theory argues that sunspots and magnetic fields are borne through the "quiet" photosphere by giant convection cells or eddies, and his calculations predict the right direction and magnitude for the convective motion superimposed on normal rotary motion.

The theorists have laboured in vain, it seems. According to the doppler-shift measurements that L. Svalgaard, P. H. Scherrer, and J. M. Wilcox describe in *Stanford University Institute for Plasma Research Report No 766*, the culprit is light scattering by dust on the mirrors and lenses.

To estimate a scattering correction, they sprinkled successively larger amounts of fine chalk dust on the objective lens and measured the percentage



Solar rotation according to doppler shift measurements (dotted lines), sunspots (full line) and magnetic regions of the photosphere (dashed line)

of scattered light 2 arc minutes off the solar limb. The rotational velocity measured in the presence of 1 per cent scattering at that position drops by 1 per cent from its true value. When properly corrected for scattered light, the doppler motions yield a solar rotation curve indistinguishable from that for sunspots. □

Breast antigen concentrates around tumours

Eadie Heyderman and colleagues at the Royal Marsden Hospital, London, have identified a specific antigen of secretory tissue which may be useful in the study and detection of breast cancer. The human breast is a highly specialised and differentiated organ. It secretes specific proteins, synthesises lactose and is stimulated by certain specific hormones. Other specialised tissues, such as the brain, have tissue specific antigens associated with them so it is not unreasonable to expect a similar antigenic determinant for the human breast.

Heyderman raised antibodies to frac-

tions of human milk and used these in an immunological fluorescent staining technique. She identified what appears to be a new differentiation antigen located in the secretory membranes of a number of organs such as the breast, stomach and pancreas unlike any antigen they have studied before.

In normal and lactating breast tissue sections, this antigen stains at the glandular surface. But where benign or malignant tumours are present, the stain picks out a high concentration of antigen round the tumour border. Indeed the antigen was located in tumours from many sites and allowed the infiltration of bone marrow cells by mammary carcinoma to be followed in detail (*Journal of Clinical Pathology*, vol 32, p 35).

Roberto Ceriani of the Children's Hospital, Oakland, California, reported the only similar antigen two years ago. (*PNAS*, vol 74, p 582). He detected a stable surface antigen specific to the normal human mammary gland. It persisted in laboratory cultures of breast cells after they have been transformed into cancer cells. Heyderman's differentiation antigen may be the same as Ceriani's mammary antigen.

Breast cancer is the commonest cancer in women and in many it is fatal. Diagnosis by mammography is frequently too late for any therapy to be effective. Therefore early immunological detection would be a distinct advantage. A specific antigen would also make it easier to study the development and spread of cancer and possibly allow antigenic patterns to be established in high-risk populations. Ceriani takes his hypothesis a step further to suggest that the antibodies specific for the mammary glands could be used as carriers for drugs which would specifically attack cancer cells, without damaging normal cells. □

Bismuth gets going on alcohol

A new procedure for the oxidation of hydroxy compounds—alcohols—to aldehydes and ketones under exceptionally mild conditions has been introduced by Professor Derek Barton and his colleagues at the Institut de Chimie des Substances Naturelles, at Gif-sur-Yvette, France. Exploiting the little-used oxidising power of the pentavalent to trivalent bismuth change with the reagent, chlorotriphenylbismuth, they have successfully produced a whole range of important aldehydes and ketones from their alcohol precursors (*JCS Chemical Communications*, vol 1978, p 1099).

Aldehydes and ketones form an important class of organic compounds: acetaldehyde, for example, is the starting point of many industrial synthetic processes. Oxidising an alcohol to an aldehyde, a well-known student exercise in introductory chemistry courses, normally makes use of acidic potassium or sodium dichromate as the standard reagent. The product has to be distilled off to prevent further oxidation to the carboxylic acid.

However, if the hydroxy group to be oxidised is surrounded by other sensitive groups, for example, carbon-carbon double bonds, then more subtle techniques are required.

The new bismuth reagent is easy to prepare in crystalline form, and is readily soluble in organic solvents such as dichloromethane and benzene. It can be measured out in exact amounts, and its by-product is easily separable from the reaction mix.

In a typical oxidation reaction, the alcohol and the bismuth reagent are stirred in dichloromethane, with excess potassium carbonate or sodium bicarbonate, until the reaction is complete. The new bismuth reagent is especially effective in oxidising allylic alcohols, where the carbon atom containing the hydroxy group is next to a carbon-carbon double bond. One of the first compounds to be synthesised this way is the aldehyde of vitamin A, a typical allylic aldehyde which plays an important role in the mechanism of sight. □

Artificial photosynthesis closes in

Gordon Wilkinson

Melvin Calvin, who won the 1961 Nobel Prize in Chemistry for establishing what happens when a plant assimilates carbon dioxide, recently intimated that artificial photosynthesis is not far away. Writing in *Accounts of Chemical Research* (vol 11, p 369), he describes chemical systems which accomplish the basic requirements for an effective solar energy device: the capture of a quantum of light, followed by its conversion to some other energy form and the storage of this energy indefinitely in a recoverable form.

Natural photosynthesis Mimicking the way green plants convert sunshine into chemical energy must start with an understanding of how the process occurs naturally. There are two main photosynthetic systems in nature: photosynthetic bacteria, which reduce carbon dioxide to carbohydrates, but cannot oxidise water to oxygen; and green plants, which can oxidise water to oxygen. For practical solar energy storage in combustible form, this oxidation step is the means by which we would produce hydrogen from water to replace natural gas.

During the past 30 years, it has become clear that photosynthesis involves two photochemical reactions—photosynthesis I and II (PS I and PS II). Figure 1 shows a schematic photosynthetic membrane. Also shown is a much simplified photoelectron transfer scheme, where an electron is donated from D (probably a manganese compound) to a pigment (P_{II}) in PS II.

The pigment molecules—of which chlorophyll is a principal component—act as antennae and harvest incident light ($h\nu_{II}$), transferring the energy from molecule to molecule until it arrives at the reaction centre trap. Here, an electronically excited molecule P_{II}^* (probably a chlorophyll dimer) reduces a molecule of plastoquinone.

Electron transfer continues through a number of pigments (including cytochrome *f*, etc) eventually reaching a hole left in PS I caused by absorption of a quantum by pigment P_I to give P_I^* . The trap for PS I (acceptor, A) is probably the iron-sulphur protein known as bound ferredoxin. Transfer of the electron continues through free ferredoxin and NADPH (nicotinamide adenine dinucleotide phosphate). Here follows the best understood part of the process—the Calvin cycle—where NADPH and ATP (adenosine triphosphate) made in the light reactions of PS I and PS II reduce carbon dioxide to carbohydrate in the dark.

Artificial photosynthesis Calvin is not alone in being close to producing an artificial photosynthetic system. Sir George Porter, director of the Royal Institution and winner of the 1967 Nobel Prize for his work on ultra-fast chemical reactions, is also near to this goal. Both groups are trying to model PS II: as Porter told us, "Excited PS I is really no problem". Writing in the *Proceedings of*

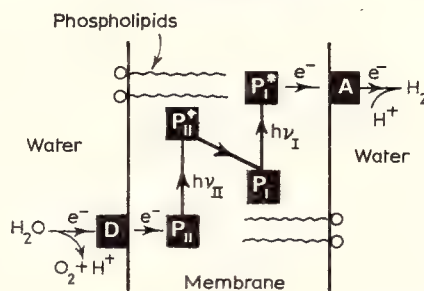
the Royal Society of London (vol 362, p 281), Porter tells us why. He states that PS II is logically the first step in photosynthesis as the water oxidation step is the least understood, and the use of PS II alone can bypass this. PS II can convert water and quinone into oxygen and hydroquinone: this provides a cyclic process for storage and release of solar energy.

Calvin's approach to the problem takes account of the fact that for the photoelectron transfer reaction to survive long enough to perform any chemistry, the electron must be transferred across a phase boundary. His group, therefore, has been attempting to achieve artificial photosynthesis at solid-liquid and liquid-liquid phase boundaries.

The former is a novel approach using semiconductor crystals and, as Calvin puts it, is a "move from chemistry to physics". Simulating PS I and PS II can be achieved using the valence and conduction bands of a semiconductor crystal. Calvin and his team have already simulated PS II with zinc oxide, sintered to improve light harvesting and sensitised with rose Bengal to absorb in the visible region, achieving an overall quantum efficiency of around 10 per cent. So far the researchers can make this particular semiconductor sensitive in the visible range to generate currents (but not gases) using phthalocyanine as a trap, but they have yet to construct a positive semiconductor for PS I to make use of the entire solar spectrum.

While the physics approach has its attractions, a liquid-liquid boundary most closely represents the natural system. Rather than attempting the difficult job of making a flat membrane to act as the boundary on the surface of water, or between two water layers, the researchers thought of using vesicles (where the membrane is effectively rolled into a sphere). However, this involves putting one dye and the hydrogen-generating system on the inside and another dye and the oxygen-generating system on the outside—not an easy task.

So to simplify the system, they make oil/water micelles; these are colloidal sized aggregates of molecules. One photo-reaction occurs at the interface on one micelle and the other on a completely different micelle. Calvin's group achieved promising results from the



Model of photosynthetic membrane showing the oxidation process on the left and reduction on the right. P_I and P_{II} are the pigments that take part in the two stage photochemical reaction

photoelectron transfer from n-alkyl porphyrin (C₁₆) in (or on) the oil micelle to quinone 2-sulphonate in the water layer. However, with the porphyrin incorporated in a phospholipid (phosphatidylcholine) vesicle, the electron transfer from the excited porphyrin to the ground state quinone acceptor is 100 000 times greater at the phase boundary than in homogeneous solution. Calvin feels that with the oxidant in one phase and the reductant in the other, it should be possible to separate the phases, store them separately and later bring them back together to recover the energy of the back reaction—thereby accomplishing the basic requirements for a useful solar energy device.

Light harvesting Back in the UK, Porter's group has been studying the other aspects of photosynthesis, one of which is the light harvesting mechanism particularly using flash photolysis. Although the group has a good understanding of how this works and can specify what is required, attempts to make an artificial system have so far failed. However, after improving their understanding of the electron transfer from chlorophyll to quinone, the British researchers seem to be even closer than Calvin to bringing about successfully the PS II reaction.

Following work on manganese complexes by Calvin in the early 1960s, Porter and Anthony Harriman are using manganese porphyrins and phthalocyanines because in nature, manganese seems to be involved in the water splitting step of plant photosynthesis they recently achieved. While stressing the preliminary nature of their work, they believe that they have the overall reaction of PS II *in vivo*—generating oxygen and hydroquinone from water and quinone. Unfortunately, the amount of oxygen was small, but Porter believes that an important reason is that evolved oxygen "poisons" the reaction. Workers in Calvin's laboratory have just solved both of these problems, and, in fact, have generated oxygen using a completely different catalyst that works on the same principle.

The low solubility of the manganese complex is another problem. Undeterred, Porter and Harriman incorporated their reactants in micelles and vesicles, so the manganese dissolves much more. Porter has said that this system is "worthy of intensive study as a possible route to the economic storage of solar energy."

It seems as if these research groups are on the last lap of one of the most important races in chemistry: both are sprinting to the finish. □

Technology

Garages wheel into electronics age

Motor mechanics are gradually leaving their traditional world of grease and spanners. They are entering the electronics age. British garages have been fairly quick to follow the enthusiasm in the United States for computer-aided testing and analysing equipment for car engines. This is despite UK car manufacturers being slow to follow another US lead—in ideas for fitting electronic equipment inside cars, for controlling ignition timing for example.

The past two years have been a bonanza for the UK garage equipment industry. The new equipment, not all of it electronic-based, has been spawned both by imports of US computer hardware, and by the tightening two years ago of the Department of Transport's annual safety check.

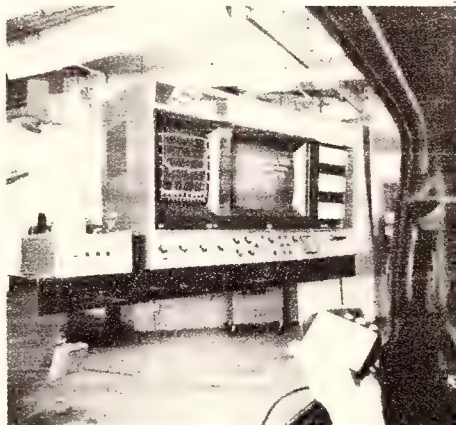
The DoT's annual safety check—still known as the MoT test—applies to cars more than three years old. Garages wishing to remain DoT agents authorised to carry out the test have until July to install all the new equipment necessary. Only some of the electronic garage equipment introduced in the past few years is strictly needed for the more rigorous DoT testing procedures. But the new climate on safety which the regulations engendered have undoubtedly helped boost sales.

Early versions of the new equipment included electronic testers that monitor such things as spark-plug voltages, ignition timing and the performance of contact breakers. But recently more sophisticated computer-aided machines, costing around £10 000, have appeared from the US. Sun Electric Corp of Crystal Lake, Illinois, and Autosense are two of the US firms that have started to sell their systems to UK garages.

Such machines run through a pre-determined test sequence to compare vehicle performance factors—ignition timing, exhaust gas composition and so on—against reference data for the car when new. The reference data are programmed into the computer on a tape.

Some of the new machines provide print-outs which give the customer an accurate record of his vehicle's performance before and after servicing. The computers can also be programmed to give the type of work, and its cost, that is required to restore the vehicle to health. The computer can even be linked to a "rolling road" to simulate road conditions. The "rolling road" is a roller which the car's wheels drive—the roller can be braked to simulate environmental conditions such as wind.

Computers for both stock control and payroll management are also being introduced in garages. It would be a logical step to combine both the administrative and diagnostic computers into a single unit. The garage's diary and its future staffing levels could then be fed into the computer, as well as vehicle data records. The machine could give the



Computer testing comes to the garage

customer an instant analysis of his or her car's faults, the repair work needed, and the earliest possible date for the work to be carried out.

A further extension of this idea could be to couple a garage's vehicle analyser via a telephone link to a central processor at the car manufacturer's headquarters, providing the maker's R&D departments with valuable data.

The equipment strictly necessary for the new DoT test is not all that sophisticated. The biggest innovation is a new brake tester which most garages carrying out DoT checks have installed. The old way of measuring brake performance was to put a decelerometer on the floor of the car and check its reading while

the brakes are engaged and the car is travelling—a notoriously inaccurate way of doing things.

The new equipment, which costs about £3000, consists of a roller placed in a trough in the garage floor. The front and back sets of the car's wheels are tested separately. The wheels are engaged against the rollers, moving very slowly at about 1 km/hour, while the brakes are applied. Through electronic transducers, a torque reading is obtained which gives an accurate measure of brake efficiency.

Exhaust emission measurements are not part of the DoT test, although equipment manufacturers are urging the government to change the rules to include them, in an attempt to reduce air pollution. Exhaust gas analysers range from simple, hand-held gadgets to complex machines incorporating solid-state electronics. The concentration of pollutants (hydrocarbons and carbon monoxide) is measured accurately by recording the gases' infrared spectrum. Besides establishing whether the vehicle conforms to statutory emission standards, measuring exhaust gas levels can tell a mechanic a lot about an engine's condition and help pinpoint areas requiring urgent attention.

Despite all these new technical ideas, however, many garages are still against innovation. As one proprietor put it: "Even the biggest computer on the market can't tell you that you've got a flat tyre." □

Pilots find the right approach

Trials of a new method of helping pilots land their aircraft safely are to be extended, with the aim of eventually replacing current equipment. The system is called PAPI (precision approach path indicator). It is easier to use, and more accurate than the existing method—VASI (visual approach slope indicator).

PAPI equipment is being installed at London's Heathrow airport: tests of PAPI are already under way at London's Gatwick airport. The visual aids panel of the International Civil Aviation Organisation says that PAPI should be evaluated as an alternative, and eventual successor, to VASI. Canada, France, the United States and the USSR all want to try out the system.

VASI is a series of bars of lights on the ground, red on top and white beneath. They are tilted at the angle of the correct approach path to the runway. The lamps are shielded so the pilot sees only the red lights if he is too low, and white if too high. A combination of the two, which appears as pink, shows that the aircraft is descending at the correct angle.

Whereas all the lights in VASI are set at the same angle, those in PAPI are staggered. There are four sets of lights—at slightly different angles—in a

line extending from the side of a runway, adjacent to the desired touch-down point.

The pilot deduces his angle of approach by checking the different colours of the four lights. For instance if he sees the two lights nearest the runway as red, and the others as white, he knows that his aircraft is within one-sixth of a degree of the correct approach angle. The system is accurate to 2 metres once the aircraft is over the runway.

PAPI has other advantages over its predecessor. A pilot sees the aggregate colour of the VASI lights, whereas the PAPI units change individually. This allows the pilot to judge more accurately whether he is on the correct path, resulting in a more even approach. This is especially important for short runways.

With VASI, both red and white lights must be visible for the aid to be helpful—and this limits its use at long distances. By contrast, the PAPI system is useful even when the aircraft is several miles from the airport. The pilot watches for the correct number of white lights and spots the less obvious red ones later on.

At Heathrow, the new PAPI equipment will be operated together with VASI on one of the runways. Pilots will be asked to say which of the two works better. □

Last week the Institution of Electrical Engineers held a one-day meeting on a subject of growing importance — small Earth stations for satellite communications. Tony Durham reports

Small is beautiful in the aerial world

In message communications over the air waves, higher frequencies mean smaller aeriels. Today's rooftop ultra-high frequency aeriels for TV, which are much smaller than the previous generation of TV aeriels, bear witness to this. The same "shrinking" process, as transmission frequencies are increasing, is now affecting aeriels for satellite communications. The early days of satellite communication used mainly the 4-6 GHz frequency band. But the latest generation of satellites receive and transmit in the 11-14 GHz band. For instance, Intelsat, the organisation that launches satellites to handle international telephone calls, is sending up an 11-14 GHz satellite later this year. Earlier generations of Intelsat hardware have used the 4-6 GHz band.

The higher frequencies mean aeriels can be made sufficiently small to be carried on a vehicle, or a person's back, or installed on a rooftop. The effects will be felt in the armed forces, in commerce, in shipping and in broadcasting.

The Independent Broadcasting Authority last year demonstrated how TV outside-broadcasts can be transmitted with a transportable 2.5 m diameter aerial (*New Scientist*, vol 80, p 27). The experiment used the Orbital Test Satellite (OTS), which the European Space

Agency launched last May.

The OTS is now being tested for transmitting digital data at very high speeds, again using small (3 m) aeriels. In a new project called STELLA, experimental data about nuclear reactions will be transmitted via the satellite. Taking part in the trials will be the European Nuclear Research Organisation (CERN) near Geneva, centres in France, Germany and Italy, and the Rutherford Laboratory in England. Nuclear physics experiments generate masses of raw data which must be interpreted by computer programs. The STELLA link, operating at one million bits per second, will allow physicists to run data from CERN experiments through computers in their



A "mini" satellite Earth station for TV

home countries.

Satellite data communications networks are also being planned for the business community. In the US, Satellite Business Systems (SBS), a company partly owned by IBM, plans to provide companies with private networks for telephone, telex, facsimile transmission, video and data communications. Users would have aeriels of 5 to 8 metres diameter, probably mounted on their office rooftops.

The problems of mass producing small cheap domestic receivers for the high frequency band around 12 GHz have not yet been overcome. With sufficient demand, the aerial dishes could be pressed from steel, like motor car parts. But there is still the problem of the "front end", the sensitive microwave amplifier which almost certainly must be mounted on the dish itself. In Europe, Philips has produced a hand-sized front-end using the latest solid-state amplifying device, a low-noise gallium arsenide field effect transistor (FET).

There are other difficulties with higher frequencies. Because the aerial "dishes" are smaller, the beams are less tightly focused than with bigger antennae, and so are broader. This can cause interference problems with other beams. □

Cashing in on the air waves

Banks are proud of the efficiency of their cheque-transfer system which involves pushing millions of bits of paper around the country every day. But as satellite communications advance to higher frequencies and thus to smaller aeriels, a radically different system of banking will become possible. The Inter-Bank Research Organisation (IBRO) has just published a study on how British banks could move into the space age.

The big banks would probably have to club together to buy a chain of 150 medium-sized Earth stations (about 5 metres in diameter) costing about £200 000 each. Telephone lines would link the stations, located in large towns, to local bank branches and cash dispensers. Point-of-sale terminals in supermarkets could be connected to the system. Big companies could connect their own computers to the banks' Earth station.

All this would depend on the availability of a suitable satellite. The first European commercial communications satellite (ECS) is due for launch in 1982. It is designed primarily for telephone and television, and will be of little use to the banks. What the banks would probably like is their own transponder (receive-transmit unit) carried on a future satellite of the ECS series.

The IBRO report foresees no great security problems over transmitting data by satellite. Satellite communications are felt to be no more vulnerable than the

Post Office's terrestrial microwave links which the banks now use. And a satellite could safely beam confidential bank information because of secure computer coding techniques. The latter are now cheap and readily available. For banks, the broadcast nature of satellite signals would be an advantage. As all messages go to all stations, switching centres or "exchanges", would not be necessary.

The big question is whether the banks need satellite communications at all. Though they are in the big league of computer users, banks could have trouble generating the minimum five million bits of data per second needed to use fully a satellite system. One possibility is that instead of cheques being sent by messenger in banks' routine cheque clearing process, facsimile images could be transmitted via satellite. Another development sure to generate massive data flows would be the introduction of direct debiting of customers' bank accounts from shop tills. But this development will take time to catch on. As IBRO's director, Charles Read, said recently, 95 per cent of all payments are still made in cash. So for most transactions, direct debiting is irrelevant.

There could be political problems too. The Post Office might oppose privately-owned Earth stations on the grounds that they cause interference—and because it sees them as a threat to its communications business. □

Soldiers look to the skies

Tomorrow's infantryman may take his orders direct from the sky. He will tune in his backpack radio to a geostationary satellite and receive on the 8 gigahertz (GHz) band allocated for military purposes. The Royal Signals and Radar Establishment at Christchurch has successfully tested a prototype satellite communications terminal which can be carried by one man.

The prototype is a 450 mm square aluminium box carried on a backpack. A shallow glass fibre reflector dish is carried on one face of the box. Still a little overweight, the unit should be slimmed down to 17 kg in its final version. The specification allows one minute for taking off the backpack and setting it up as a tripod.

Then the soldier has to find his satellite. A compass and a pocket calculator tell him roughly where to point the aerial, and a signal strength meter helps with the final adjustment. The kit does not include circuits to pick up a satellite's identifying beacon, so it is just possible to tune into the wrong satellite.

The manpack carries 3 kg of nickel-cadmium batteries, sufficient for two hours continuous operation. A small typewriter-style keyboard, microprocessor-controlled, is being developed specially for the manpack. It will be combined with a small printer to give a "hard copy" of messages. □

Technology

continued

Energy saving is a load of rubbish

With Britain's streets littered with rubbish caused by the dustmen's strike, a government-backed body has come up with an answer as to what to do with it. Millions of tonnes of municipal waste, normally buried as landfill, could be used for fuel, says the UK's Waste Management Advisory Council. In *Energy from Waste* (HMSO, £1.50), the council says between 2 and 3 million tonnes of coal, worth £40 million to £60 million (1976

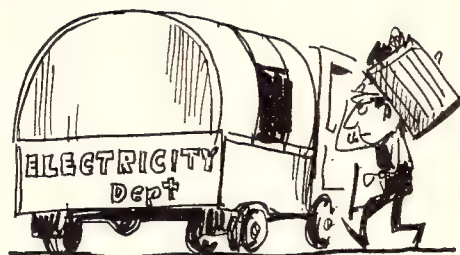
prices), could be saved each year by burning waste from households, shops and offices.

Raw, untreated municipal waste is not suitable for fuel. It is difficult to handle and burn, and equipment to prepare the waste for burning is expensive. But two schemes described in the report show that suitably treated waste can economically fire solid-fuel boilers and cement kilns. The systems were developed by Imperial Metal Industries and the cement manufacturer Blue Circle, in conjunction with West Midlands County Council and Wiltshire County Council respectively. Both schemes depend on first shredding the waste and then extracting ferrous materials, before feeding the rest of the rubbish directly into the boilers or kilns.

The report points out that the most crucial factor affecting acceptance of "waste derived fuel" (WDF) by industry is profitability. This depends on the quantity of shredded waste that can be accommodated by the system. For example the report says the minimum boiler size for an economic scheme is one producing about 25 000 kg of steam per hour. The larger the boiler the more economically attractive the system becomes.

The report says that waste fuel schemes should be particularly attractive to local authorities operating large facilities where they collect wastes for landfill sites several miles away, or to those authorities which shred their waste as a matter of course.

But in practice "industry may be more attracted by the opportunities which are likely to be opened up by current work on the more refined forms of WDF," the



report says. Two prototype reclamation plants, at Newcastle and Doncaster, are to start up this year. They will mechanically separate glass, metal and paper fibre, before producing a pelletised fuel of consistent quality. If successful, local authorities without nearby landfill sites "could find it worthwhile to build similar plants for producing waste derived fuel, and for recovering a range of other materials". A third pilot plant, at Chichester, is carrying out large scale combustion trials on these fuels. Results are expected in a few months.

The advisory council says that waste derived fuel is too impure and dirty for modern electricity power stations. "Modern power stations operate under such exacting conditions that the risk of damage from impurities is too great for them to accept even refined WDF at its present stage of development." WDF as a fuel for district heating boilers looks promising but "burning of waste . . . by individual households or blocks of flats is ruled out by problems of pollution, difficulties of operation and cost". However, regarding pollution, the report points out that "the relatively pure nature of this material (refined WDF) . . . implies emission levels of particulates and gaseous impurities below accepted limits". □

Dimples for industry

British industrialists are just about to discover the importance of dimples. The innovation soon to be thrust upon them is, more correctly, the dimpled jacket. This is the hope of the Rickmansworth firm Chem-Plant which makes stainless steel jackets for surrounding mixing vessels in industry. Oil, water, or steam is passed through the jackets to either cool or heat the contents of the mixing vessel.

In Chem-Plant's new dimpled jackets, the heat transfer fluid gets closer to a greater proportion of the vessel's contents. This is because of the dimples which project inwards into the vessel. The result is to improve the efficiency of heat transfer. As an extra, a spiral flow guide is sometimes inserted in the jacket to direct the flow of cooling or heating liquid.

So simple it seems strange that no one has thought of it before, the dimpled jacket has been found to raise heat transfer efficiency by up to 9 per cent. With a spiral flow guide the efficiency is raised by up to 50 per cent.

The dimpled jacket's main application so far is to shorten the time taken to mix heat-sensitive mixtures, such as those incorporated in confectionery manufacturing. The new jacket also saves fuel. Chem-Plant adds that the dimpled jacket's first buyers come from an impressively wide cross section of industries and nationalities. Already benefiting from dimples are a tomato puree firm in Zambia, soap and perfume oil mixers in Malta, and a plastic manufacturer in Singapore. □

Powerful floating

West Germany's plan to build an off-shore power station running off undersea gas deposits has come a step nearer fruition with the award of a contract to deliver the plant's turbine equipment. The order has gone to the Siemens subsidiary Kraftwerk Union.

The 370 MW unit, which will be operated by the Hamburg power utility Nordwest Deutsche Kraftwerke, will be in the southern part of the North Sea, 80 km to 400 km from the north European coastline. Test drillings are taking place to determine the exact site. The construction method will be to assemble the plant in a shipyard and tow it out to sea on a floating platform. The total cost will be about DM500 million. □

Dark prospects for standard video discs

Several of the world's big electronics firms are about to start a marketing battle which could eventually decide on a world standard for video discs. At least five incompatible discs, together with the video systems on which they are played, are on their way to the market place. Whichever disc survives the competition will probably emerge as the industry standard.

A standard disc is obviously in consumers' interest. It would mean people buy one type of disc and can play it on any manufacturer's system, just as they do today with gramophone records.

Philips of the Netherlands is committed to a laser-reflective optical system. This is even though the firm sold fewer than a hundred players in the system's test launch in the United States just before Christmas. Philips is the only firm to have publicly launched its video system. The others are coming soon. Sony of Japan has a similar disc and player but so far these are incompatible with Philips's.

Meanwhile, Thomson CSF of France is pushing hard with its own optical system. This also resembles Philips's, but

differs in that the disc transmits rather than reflects light. So Thomson is out of step with both Sony and Philips. Nevertheless, production of Thomson players for industrial use will start later this year.

A second Japanese firm, JVC, is committed to a grooveless capacitance disc. And RCA in the US has broken a long silence and confirmed it will make a capacitance disc, but with grooves. This again will be incompatible with the others.

A recent conference on video discs, organised by Nord Media, highlighted another standardisation problem. There is no agreement on using the discs as carriers for digital sound signals. Philips has already decided that homes of the future should have two disc players, one for video discs, and the other for discs of video type but carrying digital sound. Sony, JVC and Matsushita, on the other hand, back the idea of a single disc player, capable of playing look-alike video discs and digital audio discs. Two totally different types of players on the market would again present big problems for the consumer. □

Information, computers and people

Computers could be a big help to today's "information society". But how will they fit into the traditional methods of assimilating information which people have built up over centuries?

And, what do we really mean by information anyway?



Peter Marsh

There are two extremely important features of the age in which we live. First, the level of useful knowledge in the world is now enormous. Individuals have great trouble in keeping up with even that tiny proportion of it which is of interest to them. Secondly, thanks to the technology of micro-electronics, the computer has arrived as a cheap and convenient tool for helping people handle this wealth of knowledge. The cheap computer may have appeared, but coming to terms with it as an everyday information processor—the role for which it seems to have such huge potential—may not be easy. What changes will the computer bring to the ways we assimilate information?

To start with, "useful knowledge" needs defining. It is the sum of experience in the world that people wish to know about. Another way of describing it is as the world's

"information content". Although impossible to quantify, this is a commodity that has increased over the ages.

Information, as we use the word, arises totally out of human actions. It describes everything in the world caused by humans. And as for the characteristics of all the non-human things in the world—for instance the movement of rivers or which way the wind is blowing—they become information only after someone has interpreted them. Over the years, human actions have become increasingly interconnected. When humans first appeared on Earth they were a loose collection of individuals, with a limited interest in, or influence on, each other. But, increasingly, people found that togetherness paid. Today, the links between the actions of different individuals and groups are all-embracing, and the world of the late 1970s may be viewed as a mesh of threads joining each person to millions of his fellows.

Another way of looking at this increasingly tighter organisation is to say the world's information content is increasing. It is information, about the different groups' activities, that on one hand keeps the groups separate and, on the other, binds their actions together. This holds whether we are talking about assemblies of housewives, schoolchildren, business people, or politicians.

The information does not arise out of thin air. People generate it as part of the process by which they build around them an ever more complex social structure. Information is in many forms. It includes laws and regulations, scientific papers, business data, letters, notes, books, music scores, consumer guides, newspapers, films, as well as all the unwritten information that is transmitted verbally and is never captured in any solid form.

Today, such is the huge quantity of this information that the world is threatened with being engulfed unless we find a way of accommodating it, for sorting out what information is important and what is not. Everyday experience bears this out. People often complain that life is getting too complicated. What they really mean is that they are finding it increasingly difficult to cope with the



(Top) The Post Office's viewdata system as an information medium. (Above) This building in Houston, is a "monument to entropy", says its creator Site Inc of New York. Its "information content" is in a low-ordered form. Contrast the cathedral overleaf.

massive burden of information that the world is now routinely generating.

It is here that the importance of computers as information processors becomes apparent. Computers have been around only for a very short time, compared with the period in which the world's "information content" has been relentlessly increasing. But the level of information wasn't much of a worry to people until relatively recently. Had cheap electronic computers been invented, not in the past few years, but a century ago, not by the wildest stretch of the imagination would anyone have found much use for them in collating information. Almost by coincidence, computers have appeared—or more importantly become accessible (now that microelectronics has reduced hardware costs by such a huge amount)—at a time when the world is crying out for something to sort out the flood of information in which it is drowning.

That information and organisation are closely linked is borne out by an inspection of social laws as they have evolved through the ages. Laws are but codes of practice which draw on information about different social groups to lay down conditions to these groups' behaviour. Because human society wasn't very highly organised in its early days, the information content of ancient laws was low. The Ten Commandments, for instance, which were drawn up it is thought about 1500 BC, were straightforward to the point of being blunt.

Over the years, the information content of similar sets of rules gradually grew larger. The Magna Carta, for instance, runs to all of 63 clauses. But what would the people who drafted such documents have made of the output of today's governments? British society has grown so diffuse and complex that today it requires some 10 000 pages of legislation per year to keep it in order.

We can look at information content from the other way round—that is by considering the volume of information that society generates of its own accord, not the amount required to lubricate the structure that keeps it together. From this viewpoint, it is easy to see how information has increased. Before the Norman conquest, the amount of "useful knowledge" in Britain, if written down, would probably have amounted to a couple of hundred books. It would have included elementary details about agriculture, metal working, carpentry, astronomy and so on.

This meagre gruel of information can be contrasted to the feast available today. Science and technology are responsible for much of this. For instance, US scientists print 400 000 papers every year. Other big providers of information include education establishments, book and newspaper publishers, and commercial enterprises which produce the information in the form of memos, letters and so on.

Either way we look at information—whether we regard it as being generated as a result of, or in the formation of, increased organisation in the different societies of the world—the fact is that it is there. And because it is there, human beings usually (not always) want to keep track of it. Thus the information from a government about, for instance, tax regulations is of interest to almost everyone. People need it if they are to carry on their lives without a lot of problems.

On the other hand, information on, say, Peruvian culture will not be of interest to the bulk of the population. Other than for those who need the information for a specific task (perhaps because they wish to set up a Peruvian dancing troupe), the information, if sought at all, will be pursued as little more than a dalliance.

Here the two main types of information requirement can be introduced. People's "primary" information needs are for the knowledge they cannot do without. It is best to look at this as one might consider a board game like *Snakes and Ladders*, or a card game like whist. If people's primary information needs aren't met, they slip back a

square or two. "Secondary" information needs are not quite as urgent. If these are satisfied, it is as though the person is given a trump card which he may play later on when it could advance him a square or two. But it could just as easily produce nothing beneficial at all.

The information on tax regulations would be primary information for most people. The details about Peruvian culture would be secondary information—not vital, but nice to have just in case you ever need it. This is except for the person specially interested in Peruvian dancing. For him the information is primary: if he doesn't get it, he slips back a bit in the bid to set up his troupe.

People are surrounded all their lives by an extremely rich array of information. The individual must decide which bits are necessary to meet his primary and secondary requirements. At its most basic, primary information is the sort which people need to walk down a street without banging into stationary objects. This type of information is fairly easy to assimilate—normally just by looking ahead.

However, it is often much more difficult to gain access to some of the other, less basic, forms of primary information. This includes, for instance, what businesses must know about company law to operate efficiently; what consumers must know about the right type of food to buy without spending exorbitant sums of money; what people wanting to build houses must find out about applying for planning permission.

What about secondary information? Broadly, this is the sort that, if you get it, is a bonus. It is information that people assimilate through going to school or university, reading a novel, going to a concert, or doing a scientific experiment with no immediate end in view, other than the sheer pleasure of gaining knowledge.

As well as having different information needs, however, people's requirements for how this information is presented will vary. Information can be conveyed in either a highly ordered or a low ordered way.

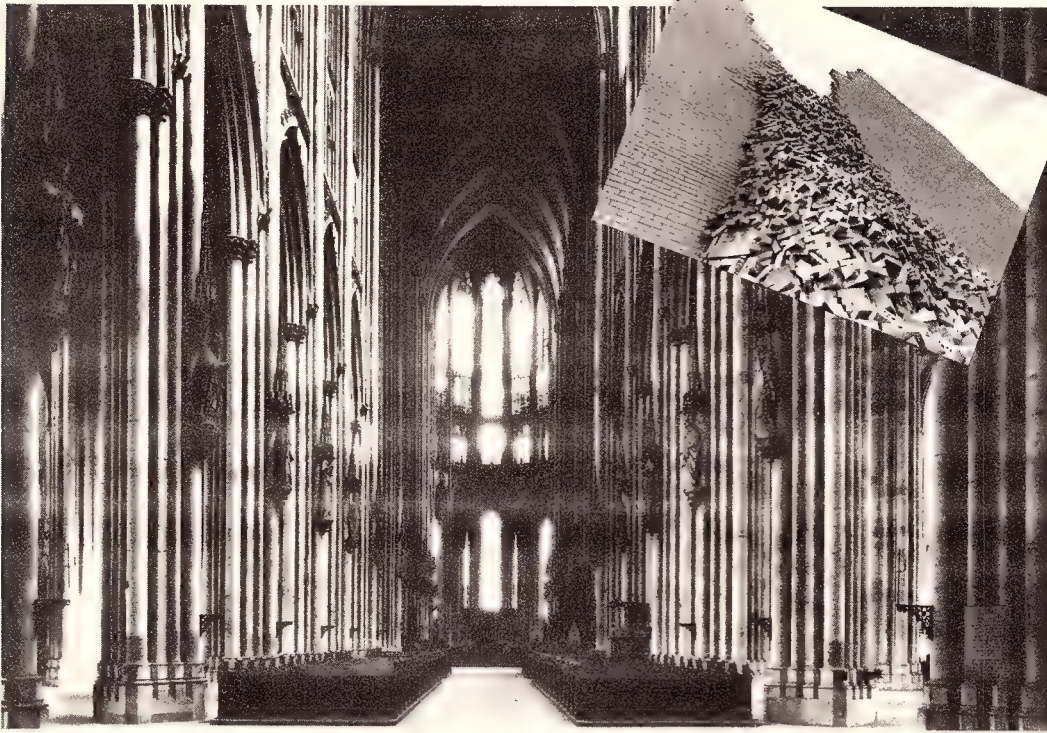
Information by the book

A tightly written textbook is a highly ordered information provider. It contains more information per 100 lines than, say, a popular magazine article on the same subject. But because of the way the book is written, it may be impossible for most people to assimilate. Talking to someone is another example of getting "low order" information. The information conveyed is punctuated with all kinds of redundancies—the "of courses" and "you knows" of speech—that help the conversation flow but do nothing to further knowledge. As information is the opposite of entropy (the quantity that shows how much disorder there is in a system), the textbook has a low entropy. The person talking is an example of high entropy.

People's likes and dislikes for different degrees of entropy must be allowed for in any information system—computerised or otherwise. We can look to the architecture of buildings for other examples of entropy, and for people's different tastes for it. A medieval cathedral is low in entropy because its form is very highly ordered. Other buildings, which are much less ordered, perhaps because they have crazy bits and pieces sticking out from them at odd points, are high in entropy. In the same way as they feel more at home with a magazine article than a textbook, people may find the information presented by such a building easier to digest than that from a Gothic cathedral.

Given that people have a range of information needs, and also have different tastes about the form in which information is presented, how can computers help? Computers have two great strengths as information processors. First, they can store, cheaply, immense amounts of information. Secondly, a computer user can get access to each piece of this information, fairly simply, by following a set of logical rules. Further, the computer, because of the logi-

Pooperfoto



The interior of Cologne Cathedral—"high order" information—compared with the detail from the "low order" Houston building

cal way in which the information is stored, is very good at helping the user in the basic sorting process which is an essential part of any efficient search for information. The knowledge seeker needs this process so he doesn't waste a lot of time combing through information in which he isn't interested. A simple example of this sorting mechanism is that a person wanting to walk down a road looks out for possible impediments to his progress only in the direction he is going—he doesn't keep turning his head to note the objects in all the other directions as well.

Computers are very useful in "primary" information searches. This type of information is the sort that lends itself to classification according to the logic rules by which computers operate. This would be the tax regulations, the details about how to apply for planning permission, and so on. The so-called "on-line" computer services which already exist meet mainly "primary" information needs. An enterprising organisation stocks a computer with information about a particular subject. The information could concern research in medicine, in which case it will be of use to doctors. Or it could deal with details about chemical products and this helps with chemical firms' primary information requirements. For a fee, a searcher links his terminal, via the telephone system, to the computer, which could be thousands of miles away. He then "interrogates" the computer, following the operating rules, to get the information he wants—which is normally flashed upon a display screen.

The commercial on-line services started life less than a decade ago. Now they handle between them about two million "interrogations" every year in Europe and North America, with the number rapidly growing. So far, they are orientated at meeting the information needs of business and scientific organisations. But there is no reason to suppose similar computer banks could not deal with the primary needs of ordinary people. They could easily help the three million people who every year contact the Citizens' Advice Bureaux in Britain, or the 60 million who make inquiries to tax and social security offices in the United States. Britain's Prestel viewdata system is an example of such a service already operating. The information to which it allows access includes details of train time-

tables, stock market information, lists of restaurants—all broad types of "primary" needs.

Concepts such as viewdata will herald a big change in the way we assimilate information. How will people adapt to the idea of words being flashed up in front of them on little screens instead of reading them on paper? People are fussy about the ways in which they digest forms of knowledge. The "entropy level" is all important. An analysis of how Britain's different newspapers present their information proves this. Newspapers in which the information is in a loosely ordered form, approaching as far as possible the "conversational mode" of information transfer, are the most popular. Other factors are also crucial to whether people accept information. Public libraries are the best examples of

institutionalised providers of information. Their advantages seem obvious, and membership is free, yet only 30 per cent of people belong to one. People dislike libraries for a variety of reasons. They might not like librarians, library rules, or they might just hate books.

Whether similar problems of acceptability are overcome will determine whether computers are any good at meeting secondary information needs. Secondary information is non-vital information, the sort where the act of getting it may be just as important as the end result. People read novels for pleasure; they may not get the same satisfaction from staring at a display screen and reading the words there. A lot of people's secondary information comes from books, TV, newspapers, conversations with other people. It is difficult to see a computer meeting this type of requirement—because the act of watching words flash up on a display screen is not a particularly pleasant way of getting information. Research at the Open University is taking place on ways of improving the "interface" between the computer and humans, in experiments where the computer takes on the role of a teaching tool. Here, the bare "secondary information" flashed onto the display terminal, is sometimes interspersed with spoken dialogue from a tutor to help the student digest his intake of knowledge.

Experiments with office workers using screens for communicating messages to each other show the extent of the problems. Attempts to break down the formality of a set of bare sentences on the screen include the insertion of words like "giggle" or "boo-hoo". These are "low entropy" words (they don't add anything to the content of the information being transmitted) which make the medium of the computer more acceptable. The designers of computer systems that directly interact with people show a similar strategy by making the computer "chatty". That is they punctuate the computer's word output with the low-entropy redundancies—"How are you today?" for instance—that occur in speech in normal life. We are only at the beginning of the era of computer information systems. They have huge potential for helping people in the basic drive to sort and assimilate information. But how people react to these new systems we really are a long way from knowing. □

A chemical clue to disease

Nuclear magnetic resonance seems to hold great promise for medical diagnosis. A meeting at the Royal Society, in London, this week will be discussing the progress of this "high technology"—here we present its controversial origins

Ros Herman

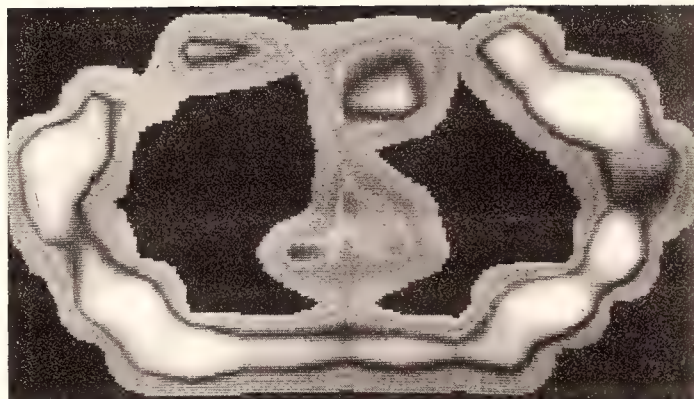
Turning medicine from an art into a science is how one of its pioneers describes the potential of a new diagnostic tool that physicists, chemists, biologists and physicians are now developing. The tool is an analytical method well established in chemistry—for small, homogeneous samples. Modern equipment and mathematical techniques may soon make it possible to analyse small regions inside the human body as if they were neat handy test tube samples—without so much as touching the skin, and with very little risk to the patient. The aim of all the new effort is rather similar to that of X-ray scanning—to pinpoint areas affected by disease. But this method is based on a physical phenomenon called nuclear magnetic resonance (NMR): radio waves stimulate transitions between "spin states" of nuclei in a magnetic field. The wavelengths of the radiation absorbed and the time taken for the nucleus to return to its original state tell much about the chemical nature of the environment of the nucleus.

The pioneer of the idea that such scanning could show up medical conditions, Raymond Damadian, associate professor of biophysics at the State University of New York, says that the technique could go a lot further than X-ray scanning. He regards this objective as the least important. A much more useful aspect of the technique, he says, is that it will be able to form a detailed chemical analysis which will identify the disease and give the physician a useful indication of how to match the abnormal chemistry with the appropriate drugs. Damadian says this could be the key to making medicine a quantitative and predictive science, rather than a matter of textbook description.

Two streams of thought led Damadian in the late 1960s to propose the idea of using NMR for diagnosing disease. The first was in his main research area—the nature of biological electricity. He and his colleague, Freeman Cope, needed for their experiments a technique that would separate water inside the cell from that outside without destroying the cell. This is what guided him to the nuclear magnetic resonance method, for which he needed expensive and unusual equipment. He gained permission to use the facilities of a small company, the Nuclear Magnetic Resonance Specialties Corporation in New Kensington, Pennsylvania. He took these cells for analysis from normal rats and rats infected with two different types of cancer. When he had taught himself, from the manual, how to use the equipment, he tried to get signals from the protons in his samples. He found that he could distinguish between normal and malignant cells, in which he already suspected the characteristics of the cells' water content would differ. He published these remarkable results in a paper in *Science* (vol 171, p 1151) in March 1971.

At the back of Damadian's mind was the crudity of the techniques available for medical diagnosis. In the early 1960s he developed a chronic stomach ache, and on consulting a fellow physician was told that he could not have discovered anything abnormal "unless it was big enough to shove a barium swallow half way across the abdomen". Damadian was thus painfully aware of the need for developing another way of detecting diseased tissues such as cancers.

Soon after the successful experiments Damadian realised that NMR could provide a means of detecting cancer and analysing the changes chemically. He immediately set



The first NMR image of a live human being made was by Raymond Damadian and his colleagues on 3 July, 1977. It shows the density of protons at the level of the eighth thoracic vertebra of the chest of Lawrence Minkoff, one of the research team. Black corresponds to zero signal amplitude, and white to the strongest recorded intensities. The upper grey feature in the centre is the heart, and the lower is the descending aorta. The two large dark areas are the lungs, and the light patches round the outside could be the intercostal muscles, with the ribs rather darker around them. The image is a black and white reproduction of a 14 colour display. It took 4½ hours to complete

to work on testing out his idea experimentally, and drafted an application for a grant. When Congress passed the National Cancer Act in 1971, Damadian looked forward to substantial funding for an idea that, he thought, couldn't lose. What Damadian did not perhaps realise was the sheer difficulty of carrying out his dream. Experimenters who had worked with NMR throughout their careers did realise how difficult it would be—and laughed at his proposals. But he maintained his belief in the idea he had hinted at in his *Science* paper—"nuclear magnetic resonance techniques combine many of the desirable features of an external probe for the detection of internal cancer"—and added to his physician's training a knowledge of physics, computing, and magnet and radio construction techniques.

So he devised a system whose principles he described in a patent (US Patent 3 789 832, filed 17 March, 1972). A large magnet sets up a magnetic field that varies throughout the subject's body. It takes on the particular value corresponding to the pulsed radio signal along just one line through the patient. The radio signal picks out one point along that line to excite—and so the resulting radio signal represents a cube on a side of just a few millimetres.

In 1974 Damadian's work attracted a large contract from the National Cancer Institute—\$200 000 for two years. But in 1976, despite promising results as reported in a further paper in *Science* (vol 194, p 1430), the institute refused to renew its contract. All other sources of funds, for example, the American Cancer Society, dried up at about the same time. Damadian's explanation of this is precisely reflected in the following passage from an article in *New Times* (February 20, 1978, p 10): "A newcomer to the NMR field without formal training, already demonstrating possible applications to human disease that NMR chemists with over 20 years' experience hadn't ever dreamed of, Damadian was bound to be deprived of an objective review by his peers." He managed to keep going somehow, and in 1977 made the world's first scan of a live human being in

How does NMR work?

The nucleus of an atom is like a small, spinning bar magnet—we say it has both spin and a magnetic moment. What happens to a bar magnet field? If it is free to move and there is no friction, it oscillates around the field direction. The friction of the medium tends to dampen the oscillations and the magnet finally comes to rest in the direction of the field. If the bar magnet is spinning about its long axis, then instead of oscillating, it follows a circular path around the field direction and is said to precess. Friction again leads to a gradual decay to the original position.

The motion of the nucleus in a magnetic field is very similar to this in many aspects. The "friction" for the nucleus, however, is due to processes by which the nuclear spin system loses energy to its surroundings. For each nucleus, under specified conditions, this decay takes place at a certain rate, and this rate defines the characteristic time known as the "spin lattice relaxation time". It is essentially the time it takes for the nuclear spin system to reach equilibrium after the magnetic field has been turned on.

Once the spins are in equilibrium, the majority point in the field direction. Some nuclei acquire extra energy from the random movements in the material, and point in the opposite direction. In magnetic fields up to 3 tesla the energy difference between those aligned with the field and those aligned against it is small. The spins may be "flipped" so that they change their orientation by absorbing a photon of electro-magnetic radiation at radio frequency. This absorption by the "nuclear spin system" in the presence of a static magnetic field is called nuclear magnetic resonance.

As the nucleus is a quantum system, the size of the spin can only take one of a discrete set of values. For example the hydrogen nucleus, it can take on just two values of spin, $+\frac{1}{2}$, or $-\frac{1}{2}$, which in the absence of a field have the same energy. (see Figure 1). Applying a magnetic field, B_0 , pushes the levels to slightly different energies because it determines a direction in space in which the spins have a minimum energy. A photon can only be absorbed by a nucleus if its frequency corresponds to the energy difference between two adjacent

levels in a particular applied magnetic field. This is called the Larmor frequency.

The hydrogen nucleus is the easiest to detect and therefore it will come as no surprise that it was the first nucleus to show an NMR signal. Absorption at the resonant frequency, however, cannot just be detected by passing a radio-frequency signal through a sample. It is very difficult to measure a decrease in the transmitted radiation even for the most favourable case of the hydrogen nuclei in a water molecule. To overcome this problem a tuned circuit is used. The sample is inserted into the centre of the coil which is placed in the gap of a magnet. A continuous radio frequency signal is injected into the tuned circuit at its Larmor resonant frequency, ie ω_L . The quality factor is then measured as the magnetic field is swept through the resonant point, B_0 . This gives the NMR absorption line when plotted against the magnetic field.

Up to now, the greatest impact of the NMR technique has been in organic chemistry and biochemistry, where it provides a powerful means of identifying and analysing the structure of complex molecules. Using carbon NMR with special mathematical techniques enabled researchers to map the carbon skeleton of many large biological molecules.

When a molecule is placed in a magnetic field the electrons circulate around the nuclei and effectively produce an opposing field at the nucleus of each constituent atom. Thus each nucleus is effectively shielded from any applied field by an amount which depends on the electron density around that particular nucleus. The electron density is directly related to the type of chemical bond and hence the environment of the atom.

Because of this the applied field needed to bring the same nucleus in chemically distinct site into resonance (at a given frequency) is different. Therefore as the magnetic field is swept various lines are obtained due to nuclei in different chemical environments.

So far we have seen how NMR can be used to observe the microscopic world. But how can this technique produce macroscopic images such as that at the beginning of this article? The key lies in the resonance equation, $\omega_L = \gamma B_0$. Clearly if B_0 is varied then the resonance

frequency also changes.

Imagine a sample containing water. If an NMR experiment were performed then a single resonance line from the hydrogen nuclei protons would result. However, if local field gradients existed throughout the sample then there would be a spread in the Larmor frequencies and the line will be broadened. This effect has been known for many years and has been used to measure magnetic field homogeneity. Now suppose the sample was placed in an applied magnetic field that was very homogeneous but with a known linear field gradient across it. The Larmor frequencies would again vary but this time in a known manner and, in fact, the NMR spectral line would reflect the "character" of the subject.

If the proton density varied in the specimen then the intensity of the signal would change accordingly and the NMR line would be a one-dimensional projection of the sample's proton density integrated along planes perpendicular to the gradient direction. The line can then be calibrated in terms of distance as the gradient is known. Choosing another direction for the gradient allows another projection to be formed. A number of projections can be obtained, by repeating this process. In this way, an image showing the density of protons in a slice of the original object can be built up. This is performed on a computer using one of several reconstruction techniques.

How this is achieved may be understood simply by considering the intensity of a particular line to be represented by the blackening on a photographic film. If a number of these were arranged at the same angles as the original gradients and then lit from behind the shadow picture formed in the centre would correspond to a cross-section of proton density on the sample as Figure 2 attempts to show. A technique very similar to this was used by Professor Paul Lauterbur of the State University of Stony Brook to produce the first NMR images of proton density from one-dimensional projections. He, in fact, christened the method *zeugmatography*—from the Greek "*zeugma*"—"that which is used for joining".

Stewart Male

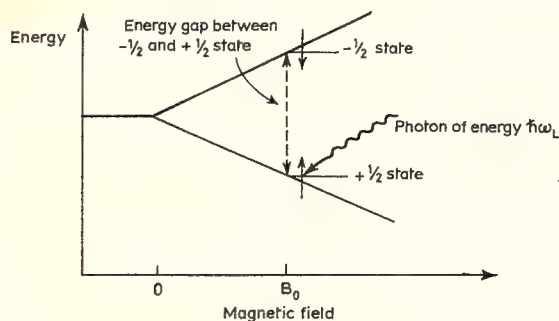
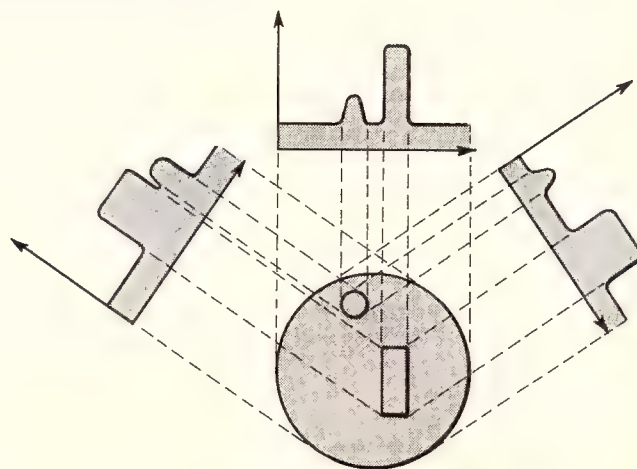


Figure 1 (above) How energy levels of the hydrogen nucleus separate in a magnetic field
Figure 2 (right) Detail in a sample shows up in signals taken from a one-dimensional image



his laboratory at the Downstate Medical Center in Brooklyn, New York.

Despite the initial lack of enthusiasm, Damadian was not for long the only researcher working towards NMR scanning. In September 1971 Paul Lauterbur, an NMR chemist at the State University of New York at Stony Brook, who had already begun to think about applications of NMR in biology and medicine during a sabbatical year in 1969-70 at Stanford University, came up with a slightly different approach. Lauterbur was familiar with the results of Damadian's experiments with rat cells—he had been brought in to help sort out the affairs of the company where they had been carried out. He also was impressed by the different characteristics shown by normal and cancer tissues.

Lauterbur realised that one of the major problems of NMR with large samples, that of getting a homogeneous magnetic field so the signal would come from all over the sample, could be turned on its head. From a signal in an inhomogeneous field, information coming from the different directions around the sample, can be processed mathematically (see Box).

Crackerjack of an idea

Lauterbur says that when the idea came to him he had not heard that Damadian was already beginning to exploit a similar idea. Furthermore, he had not heard of the computer reconstruction technique, similar indeed to his own, that Godfrey Hounsfield was working on for processing X-ray pictures on the EMI computed tomography machine that was brought out in 1971. He was immediately conscious that he was on to a "crackerjack of an idea", as he describes it, and so he wrote out his proposal at the beginning of a notebook, together with a reference to Damadian's *Science* paper on cell differences to show its applications, dated all this, and asked a colleague to countersign it. Eventually, he decided to publish it in *Nature* (vol 242, p 190). He planned to write about his proposed scheme on its own at first, with a follow-up paper on the possible applications. But the referees couldn't work out from the first paper what the technique could possibly be used for, so to ensure publication he was forced to add a note about the possibility that it could be used to diagnose cancer. But when the paper was finally published in March 1973, it failed to refer to Damadian's work—an omission repeated throughout Lauterbur's publications over the next few years. This strange omission has led Damadian to accuse Lauterbur of trying to steal his idea, and has caused much acrimony.

In recent years Lauterbur has mentioned Damadian's work, but without describing it as seminal. For example, in a bibliography on NMR scanning that Lauterbur prepared in January 1979, he mentioned Damadian's 1976 *Science* paper, but not the earlier one published in 1971.

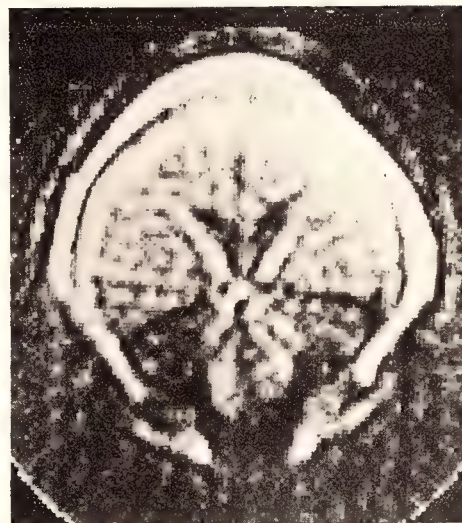
Damadian feels snubbed and outcast by the NMR research community, and he has pushed forward his ideas in an isolation which is perhaps glorious, but has also made him fairly miserable as a scientist. (This has been somewhat remedied in recent years by invitations to speak at conferences, such as the Royal Society this week.) Lauterbur, on the other hand, has played a full part as the "father figure" in the NMR imaging community, which began to grow soon after the 1973 *Nature* paper was published. One centre where magnetic field gradients had been used before in NMR was Nottingham University, where Professor Raymond Andrew and Dr Peter Mansfield had worked with the Royal Radar Establishment on a means of information storage using field gradients in 1967. Nottingham was also a centre for using NMR for analysis of the structure of large biological molecules.

During the early 1970s, the physics department at Nottingham accommodated two separate efforts towards

NMR imaging. These differed from Damadian's and Lauterbur's methods, and from each other in the way the magnetic fields were applied, and the resulting signals processed. Dr Waldo Hinshaw came from the University of North Carolina to work with Andrew in 1971. In 1974 he published the "sensitive point" method for imaging (*Physics Letters*, vol A 48, p 87) and worked on implementing it.

Peter Mansfield devised the "selective irradiation technique" which he has since further developed theoretically as well as practically. He obtained a magnet big enough to take a human being in early 1978, and by March he had made a proton density image of himself at the level of the hip (*New Scientist*, vol 78, p 805). Other researchers in the US and Europe have come up with different approaches—these now number about eight. According to Lauterbur "as yet there is no honest professional assessment of different handling techniques".

Lauterbur says that he is going more slowly in order to get to the end of the road using the best method, although he does admit that he expected to be ready to do large animal and whole body scans sooner. Certainly, he has tried combinations of his original technique with several others, and has pursued slightly divergent interests, such as flow imaging. He has decided to go for a very ambitious reconstruction technique which in one go will

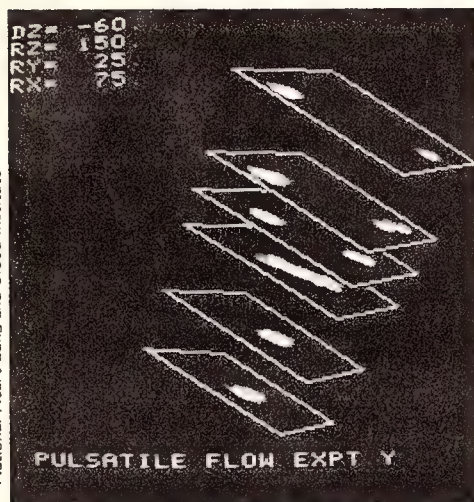


Proton density map of a section through the head of Hugh Clow, made by him and his colleagues at EMI in 1978. At the top of the picture the black patches represent the orbits—the eye sockets and eyeballs. The ventricles of the brain are also visible. This scan took six minutes to make

make three-dimensional images of a thick wedge of the body, equivalent to many of the "slices" in the X-ray technique. This approach, he thinks, will result in quick scans—and the quicker the scans, the more efficiently the necessary equipment and staff will be used.

As soon as whole body imaging seemed a feasible objective, its diagnostic and analytical potential made it a sufficiently attractive commercial proposition that equipment companies started to watch what was going on. The British company EMI, proud of its world first with the computed tomography X-ray scanner, was one of the first to become actively involved. Dr Hugh Clow began work in 1975 on the theory of NMR scanning and later combined forces with Dr Ian Young of the systems group. He was helped by Mansfield and Andrew at Nottingham—EMI retained them as consultants. EMI published a head scan (of Dr Hugh Clow) last November. Clow and Young use a reconstruction technique based on Lauterbur's approach—this fits in very well with methods already available from the X-ray scanner.

At the time, a spokesman for EMI forecast that it could have the scanner on the market within five years. He was rather coy about the price but he suggested that the different models would range around the cost of the X-ray computed tomography scanner, which is now about £500 000 for a whole body version. Equipment for



Paul Lauterbur and his colleague Ching-Ming Lai made this NMR image of proton density in a phantom in which blood flow was simulated by passing water through a forked tube. They filtered the signal so that only the pulsing water shows up. The object of the project was to find out whether they could use NMR to study blood flow and detect atherosclerosis non-invasively

specialised tasks, such as breast scanning, could be substantially cheaper, he added.

EMI may have (literally) a head start on the other companies, but it will not be left alone in the field, not even in the UK. The General Electric Company wooed Waldo Hinshaw away from Nottingham, although he only stayed a few months before moving on. He is now working at the Massachusetts General Hospital in Boston. Many other companies around the world are also working in NMR imaging or keeping a "watching brief".

The images that the physicists, chemists and computer experts have been putting together so far have been almost exclusively maps of the density of mobile protons, or, roughly speaking, the water content. A more useful parameter is the time the radio frequency signal takes to decay, and this is what Damadian's discovery found to vary between malignant and normal cells. NMR experts today have not shown any clear criterion by which they will be able to distinguish between the two in humans. This is largely because the times taken for the signal to decay in tissues of various organs can vary widely, according to a large number of other factors. In one disturbing set of experiments on normal and tumour tissue from rats, the signals crossed-over each other and came back again for no apparent reason. Lauterbur says that it doesn't actually matter too much that we can't explain every change. The test of the method will come when physicians use it for diagnosis—they will be more interested in the number of false diagnoses shown up by follow-up trials.

Damadian is still intent on using NMR for cancer diagnosis, and he and his colleagues have conducted many experiments that have confirmed to his satisfaction that he can distinguish normal from malignant cells by using an "index" combining several NMR measurements. He has also taken several whole body images of cancer patients, in which he can see the area of diseased tissue. But other researchers, such as Lauterbur, think that proton NMR may well be more useful in conditions more closely related to water content and movement, such as oedemas, heart disease, and circulation problems. Lauterbur is already working on ways of enhancing the signal by injecting paramagnetic ions, which are like tiny permanent magnets, into the bloodstream. These enhance the local magnetic field and ultimately make the signal three or four times stronger. The method is roughly equivalent to the injection of contrast media to show up otherwise unseen areas in X-ray pictures. So far he has only tried it on hearts, where he has managed to highlight certain regions by cutting them off from the supply of blood carrying manganese ions. Lauterbur also speculates that this method might reveal malignancies.

Much more closely related to human metabolism than

water concentration is the energy cycle of the cell, involving changes in the chemical state of the element phosphorus. Phosphorus can also be imaged using NMR, and many researchers have used this method to follow the cycle in different types of tissue. NMR will not only measure the concentration of phosphorus, but will also give a good idea of the chemical environment of the atoms, so if abnormalities in metabolism can be related to particular diseases, an NMR image should pick out a lot of useful information. Many researchers are using phosphorus NMR for studying metabolism, but the problem is that the signal from phosphorus is much smaller than that from water, and is going to be much more difficult to apply to whole body imaging.

It is this sort of idea that led Damadian to make the ambitious claims for NMR that appear at the beginning of the article. He looks forward to the time when he can make a complete chemical analysis of a selected region by taking high resolution NMR spectra of a number of different atoms—of protons, phosphorus, sodium, and possibly carbon and nitrogen. He says that this will enable him to say "with a high degree of confidence" what is going on there. He is interested not only in the chemistry of cancer, but also in the chemical changes associated with other unexplained diseases, such as mental illness.

Partly because it is so difficult to make accurate forecasts about what use NMR will be in diagnosis, its proponents make great play of the safety of the method as compared with X-ray and radiochemical techniques, both of which require ionising radiation to pass through the tissue. The NMR technique imposes two different conditions on the patient: a high magnetic field, and a pulse of radio frequency energy. In some approaches the fields vary very quickly, and develop potential differences.

Safer than X-rays?

Thomas Budinger of the electrical engineering and computer sciences department of the University of California has examined a vast amount of literature (he lists 52 references) and added his own calculations in assessing the likely biological hazards of NMR. He lists three aspects of NMR body imaging that could affect health: the heating due to the radio frequency power, the static magnetic field, and the electric current induction due to rapid change in magnetic field. The first two hazards, he says, are unlikely to affect NMR imaging efforts in the near future. Research has shown that below certain levels, there is no significant biological effect, and it will be easy to keep within these levels in NMR imaging. The third hazard needs more careful attention, and Budinger suggests that fields should not vary at a rate faster than 3 tesla per second. Lauterbur suggests that this consideration may make some approaches to imaging—Mansfield's selective excitation in switched magnetic field gradients, for example—less attractive.

Assuming that sensible precautions are observed, current knowledge suggests that NMR does have less of a safety risk associated with it than the X-ray techniques now used for diagnosis. But clearly the lesson of X-rays, showing that it can take a long time for unexpected hazards to be associated with their cause, will stimulate physicians to keep a close eye on patients diagnosed by NMR. Peter Mansfield took the precaution of subjecting live rabbits, rats, guinea-pigs, and a cat to switched gradients before experimenting on himself—with no apparent ill-effect.

EMI's public declaration that it is going ahead with building prototypes with a view to producing commercial models in five years time has now set the pace not only for other companies, but also for research system builders, physiologists and physicians. It looks as though health planners, already baffled by the wide range of medical technologies available, could soon have another to add to, or reject from, their shopping lists. □

Feedback

Were UFOs really squid boats?

The Royal New Zealand Air Force has firmly pooh-poohed the widely-reported suggestion that the antipodean nation was visited by UFOs just before Christmas. The televised "UFOs" were, says the air force, the result of natural but unusual atmospheric phenomena.

Unidentified radar and visual sightings were reported by aircraft and air traffic control radars off the north-east coast of South Island on the nights of the 20 and 30 December last year.

New Zealand's air force investigated the incidents and discovered that the Wellington air traffic control radar has re-

ceived spurious returns from this area for some time. During December and early January, the air force says, atmospheric conditions were conducive to freak effects of radar and light waves.

One bizarre explanation of the lights in the sky is that they may have been caused by Japanese boats fishing for squid. Over the period of the sightings more than 50 of these boats sailed from Wellington to their fishing grounds about 170 km off the coast. According to the air force, the squid boats would be a good source of radar returns while sailing to the fishing grounds. And the brilliant

lights the squid boats use to attract their prey "cannot be discounted" as a cause of some of the visual sightings.

Another possible culprit for the visual sightings is the planet Venus which was then shining in the eastern sky.

The air force investigation claims that the brilliant lights filmed by an airborne television crew (and later shown throughout the world) were not related to radar sightings at Christchurch or Wellington. The New Zealand Ministry of Defence says that it is "completely satisfied" that there were no unexplained physical objects in the skies at the time of the sightings. But would they tell us if there were unexplained objects? □

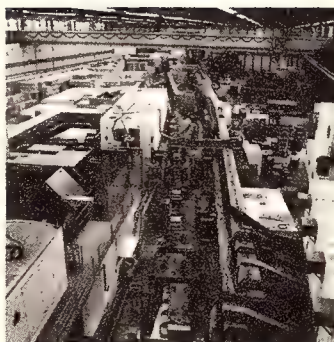
Cost/benefit analyst

It's always interesting to see a wife taking a real interest in her husband's activities. From a recent issue of the Society of Chemical Industry's *Bulletin of News and Events*, it appears that the wife of one of the society's leading lights has just become a member. This year, the society, which is based on London, but has substantial membership in other parts of the world, is holding its annual meeting in New York. Toward the end of last year, the society discreetly announced that it had funds at its disposal to assist members not otherwise sponsored to attend this meeting. It gave no details of how much it was prepared to fork out to any one person, but it seems unlikely to be less than several times the annual subscription of £10. Surely, the good lady

mentioned above cannot possibly have had such assistance in mind when deciding to apply for membership of such an august society? □

Postal proliferation

There is a not inconsiderable part of the scientific community which believes that high energy physics, and its major European manifestation, the CERN research centre in Switzerland, are expensive luxuries. It isn't surprising, therefore, that the laboratory should maintain a sizeable public relations exercise to dispel this misapprehension. But surely it is counter-productive when this PR machine sends as many as a dozen envelopes to our office in the same post? It isn't as if CERN had a lot to say—there were only two bits of paper, but six copies of each. While we can use a



couple of copies of each epistle, our dustbins aren't big enough for the rest. □

Museum of Horrors

Those of squeamish disposition may never feel the same again in the Natural History Museum in London. That haven of the taxidermist, where everything remains still and lifeless, stuffed to rigidity, has been violated. For a rare species of spider has been found on the wall—and it was alive. Taxonomists, excited by the presence of this small spider, identified it as *Oecobius annulipes*.

This is not the first time a live spider has been found in the museum. Just over five years ago a spider of the same genus was discovered. And more recently adults of both sexes of the species were found in a packing case.

Dr Mark Ritchie, of the Centre for Overseas Pest Research in London, believes a sizeable colony of the spiders is living in the museum. Originally they could have been imported in a packing case from the Americas, Asia or oceanic islands where the spider is indigenous. □

Is it a jet? No it's . . .

When is a reactor not a reactor? Answer: when it's a jet. The Institution of Mechanical Engineers recently sent out a flier to the press notifying them of the imminent James Clayton lecture. The Clayton is the Mechanical's big annual public lecture and this year it looked a peach. According to the Mechanical's hand-out, we were to be treated to the first public detailed assessment of JET, "the first nuclear fusion reactor in Europe", by Dr M. Huguet head of the Magnet Systems Division of the JET project at Culham. Unfortunately, people keen to hear about the first fusion reactor will have been extremely disappointed because the JET project at Culham is still in its research infancy. So far, the Culham researchers have not yet achieved sustained fusion, let alone built a reactor. □

Below the salt

Engineers, as we all know by now, are sensitive flowers, upset at the tiniest suggestion that they are in any way inferior to anybody else and distraught at their poor status and starvation-level salaries. The Cranfield Institute of Technology is foremost among the hothouses cultivating the prickly pride of the profession.

One of Cranfield's engineering professors recently insisted that the members of two of his courses dine in the luxurious "study centre" recently opened at the institute and not in the common or garden college dining room. Whatever next? The key to the executive ablutions? □

Superstar

A shortage of press coverage of the business of the Department of Education and Science should not be seen as a sign of a lack of activity on the department's part. It is just that the ministry's press office has had other things on its mind and hasn't been able to do justice to the reports, and so on, that emerge from the DES.

Why is the DES's press office so preoccupied with other things? It seems that the Education Secretary is very busy making statements about the effect of strikes on education, and the press department has been told to give the thoughts of chairman Williams every attention. □

Turin crowd

Readers transfixed by the debate about the authenticity of the Turin Shroud will soon have the opportunity to examine the evidence more closely. Not, of course, the shroud itself. But an exhibition of photographs of the shroud and other material on the Turin curiosity is to visit Westminster Cathedral from 5 April. Penguin Books Ltd also plans splash advertising for the paperback edition of Ian Wilson's book on the shroud and the BBC is to run *Silent Witness*, a documentary about the shroud, just before Easter. Remember the old days of barbaric superstition when mountebanks used to sell bits of saint's clothing or toe-nails or whatever? □

FRAGMENTS OF THE HOLY SHOOTING SCRIPT!

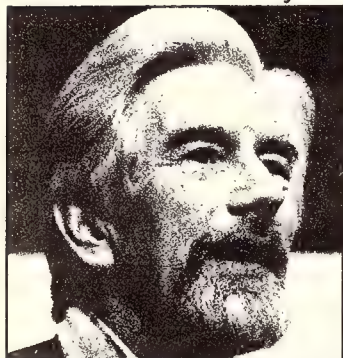


Forum

OUT AND ABOUT

The iceman goeth

John Hillaby



Or so at least we hope. One swallow, I know, doesn't make a summer, but the cheerful sound of that otherwise inconspicuous little bird, the chiff-chaff, the one that constantly proclaims its name, is a token of spring more valid than flowering celandine, dog's mercury, chickweeds, coltsfoot and *Caltha*, the enormously gold marigolds of the marshes. The pity is that the harbingers might well die of their endocrinal urges to get into the

best sites first. There is no going back.

Ebullient finches and that counter-tenor of the tree tops, the mistlethrush, can sing their heads off in the spring and then shut up, sulkily resuming their winter silence if a mere calendar proves them not so much wrong as adaptively right, to survive on different diets. The hedgehog, too, can waddle back to his bed of leaves and dream of God knows what. Perhaps saucers of bread and milk in the Garden Suburb. Not so the chiff. He has turned up at least a fortnight ahead of his usual time. I have forgotten for the moment where he comes from but, as Aldo Leopold nicely puts it, his arrival carries the conviction of a prophet who has burned both his boats and his bridges.

And what does that venturesome chap feed on when he gets here? The all-holy *Handbook* says "On arrival chiefly Diptera (*Chironomidae*).". But this is dead wrong should the weather prove really hard. For quite different reasons, the answer lies in his generic name, *Phylloscopus*, the leaf explorer. It is true that later in the year you may find him hunting aphids among birches, but this week he has been turning over dead leaves on the ground like any hungry blackbird, looking, I suppose, for mites and Collembola, or springtails, those creatures that feed on decaying vegetable matter. Because of their great antiquity, they are perhaps the most interesting of all the soil insects. Fossils not unlike living species go back some 300 million years, to the Lower Devonian.

This afternoon, when the sun flared over one of the smaller Hampstead ponds so powerfully that it steamed, the chiff shifted his pitch and ate what he is supposed to eat. But not (will *The Handbook* editors please note) chironomids. At no mean risk to a dry home-coming I scooped a newly-emerging culicid, a harmless mosquito from the surface and managed to identify *Chaoborus*, the adult form of the Phantom or Ghost larvae. Over several years, this small goblet of fact confirms what I have several times seen but not pursued. Simple research might well show that, like swallows, the chiffs arrive behind a widespread and steady thermocline.

The appearance of the first solitary bees, especially those of genus *Andrena* seems to be finely timed to the flowering of ragwort and willows. As soon as the silvery catkins are yellowed over with pollen, the exposed sands of the Heath are dotted over with the conical approaches to the bees' burrows, some of them two feet deep. They haven't yet appeared, but in the woodlands, and unusually early, were what I took to be the larval chambers of that extremely common and athletic little ground beetle, *Nebria*. A portent? And if so of what? A pity we never seem to hear from the Biological Records Centre on these points.

If the snow returns, as it may well, I am resolved to spend more time looking at animal tracks. During the last heavy fall it was interesting to see how closely the grey squirrels kept to quite narrow "lanes" on open ground between clumps of trees. These lanes, though by no means always the shortest routes, were more noticeable for the animals' abundant raisin-like droppings than the tracks of their relatively broad feet. When hotly pursued and cornered at the top of an isolated tree by another squirrel, some showed no hesitation in leaping into the air and

landing on thick banks of snow from a height of 30 or 40 feet.

The other week, as the lake in St James' park slowly froze, a great commotion of mallard, pochard and tufted duck swam round and round trying, it seemed, to keep open the last patch of ice-free water. The blackheaded gulls quit early. They rose higher and higher on a thermal above Buckingham Palace and drifted west. The last to vanish in the throng were a pair of buzzards. Now where on earth had they been? □

EXPERIENCE

Early Promise

Roy Herbert

I was a pioneer of science fiction at the age of 17. Pioneers are not necessarily celebrated. "Pioneers O pioneers!" said Walt Whitman, leaving us much as we were before on the subject. It adds little—as much as saying, "Wheelwright's assistants O wheelwright's assistants!" adds to our knowledge of the ardours and disappointments of helping to make wheels. Before this, I agree, Walt had asked the pioneers a few questions of singular tedium, such as, "Have you your pistols? Have you your sharp-edged axes?" Well, unarmed pioneers with blunt-edged axes wouldn't have got far in the American West and I don't suppose they needed Walt to check on their equipment before they trundled off in their prairie schooners.

"Pioneers O pioneers!" is in all the anthologies, for some reason. The line always puts me off. It sounded too much like an American name, for a start. Pioneers Orville Pioneers. P. Otis Pioneers, Jr. It takes a really fine writer to be able to cope with a single capital letter. The only man I have found who could handle a single cap and bend it to his will was P. G. Wodehouse. In one of his novels a bus conductor is taking money and issuing tickets with the use of an appreciative consonant "Q", says the conductor.

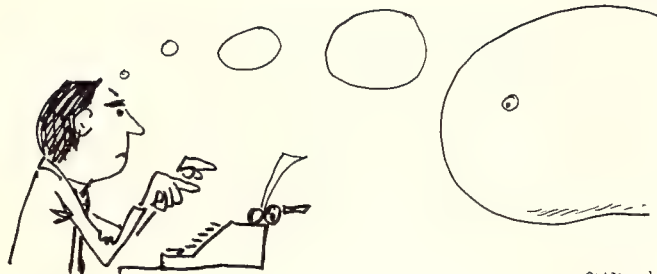
When I was pioneering I had no pistol but I did have the equivalent of a blunt-edged axe. It was a typewriter, bought in an auction sale which, for reasons I could never fathom but no doubt made sense at the time to Underwood, the manufacturer, showed no result when you hit the keys. The type bars struck up from below like miners' picks on a roof seam and to find out what you had written, you had to lift the entire platen. The scheme made it hard to correct mistakes because you didn't know you had made any. To this day I am still nervous of backspace and shiftlock. The typebars formed a kind of cage. You could have kept a parrot in that machine. As I was interested in surrealism, the idea had a certain appeal. I felt that a parrot in a typewriter was as good as the famous definition of surrealism as a sewing machine on an operating table. But I knew of no parrot pushed for accommodation.

On the Underwood I clattered out novel after novel, even discovering the technique of the stream of consciousness only a decade or two after James Joyce. One of the problems was titles, as evidenced by 23 attempts on a first page, including *Distant Square*, *Life like Siena Cathedral* (a cultural show-off, as anyone knows that Siena Cathedral's facade is mostly sham) and even *Sorrow's Crown*. Nothing much happened in any of these masterpieces by which I was going to take the publishing world by the throat. Mostly it was the torture of love. But there was a different kind of torture in *Sorrow's Crown* and here we are getting to the frontier. The really agonising circumstance for the hero was that he had to live with his family, and a bunch of lower middle-class bores, idiots and insensitive dumpties they were. Poor old Dad couldn't even do a bit of gardening without copping it from the hero, who was under the impression that there was some mystery about his (not Dad's) birth. Strolling in the open air to escape the massed philistines, the hero has this thought to offer, "I always felt that the barrier which blocked the ornamental garden from potatoes and peas was the essence of smug hypocrisy. The potatoes stood up in their furrows self-consciously."

The breakthrough and I didn't recognise it! I had invented the self-conscious potato. It's taken me all this time to find out that I had a gold mine ready for exploitation and passed it

Forum

continued



PEYTON

by, oblivious of the gleam. For it's pretty clear that a self-conscious potato would soon start lurching about the landscape, getting its own back on the human race. It would get huge because of the escape of radioactivity from a nearby nuclear establishment and rear out of the ground in the night to attack the suburbs. I can see it now, the huge shape of a King Edward or a Maris Piper looming blackly over the trees, an unsuspecting family sleeping below. Next the crash of glass as the shoots come through the window, the slump of the roof to ruin under the pressure of the massive load of starch. The potato—and all the other potatoes by that point—would be impervious to gunfire. Gathering their forces in clamps, they would be increasing all the time. "My God, they're chitting!" would be the wild cry of a crazed artillery officer facing the menace with puny weapons. Inexorably, the hordes of Arran Chief and Désirée would advance across the country. Until—the quiet, decisive hero, from Rothamsted, seizes the only chance. Flying over the heaving mass of potatoes preparing to put London to the tuber, at Barnet, he sprays them with potato blight.

I have, of course, thought of a title for this adventure: *The white has a thousand eyes*. It's not all that good, I know, but I think it's an improvement on *Sorrow's Crown*. □

MEDIA MESSAGES

Cashing in

Tim Robinson

It was, last time round, "a frenzied scramble. Everyone piled in on the act. The only thing that many of them had in common was that they knew nothing about television and couldn't care a fig about its history, its purpose, or its future." Thus Milton Shulman, on the last circus designed to allocate ITV franchises to these groups of people best fitted to serve the often rather obscure purposes of the Television Act, 1964.

Well, folks, it is all going to happen again. This autumn a rather undignified set-to will be taking place in the Brompton Road. The IBA has promised an added attraction in that those trying to get their sticky little fingers on possibly the most lucrative series of monopolies in British industry for upwards of a decade, will, we are told, actually have to tell us *before* they get the prize what they might do with it.

The cries of dismay from the incumbents at this pathetic gesture towards the idea that you and I ought to have a say in who or what uses up valuable air waves will continue to cascade around us all. I have to say that I am perpetually flabbergasted at the public cheek of men who seem to feel that they have a divine right to dictate public taste, nightly, on what they have come to regard, through successive governments' default, as *their* channel.

Because of a design error written—some would say deliberately—into the Television Act, the IBA, that body which ought to be in some kind of control of the TV companies, can only act negatively against them. And in the end, as commercial television companies have never tired of telling any IBA official who might step out of the party line (and *the* line is making seemingly limitless profits), it is the IBA who looks foolish if it has to admit this time round that the people it chose last time really turned out to be a bunch of rogues.

The key to the IBA's impotence lies in its not having an independent source of income. All its money comes from the

rental the programme companies pay for use of the IBA's transmitters. This means the IBA has no meaningful control over programme quality, programme scheduling, or over advertising policies. Once in a long while it gets to hand out the franchises—possibly the only moment of some power. But this moment of power is rather like the sovereign's over vetoing a bill. There is a considerable fatal element in using it. Additionally, programme companies know how infrequently the IBA has been able to consider changes in the original system, now in existence for just on 25 years.

Since 1954, when the ITA (then it just dealt with commercial television) came into existence, there have been only two other occasions when the renewal of franchises has come up. One of these occasions, in 1964, was purely nominal, in that at that time a lot of people thought the government would shortly authorise ITV2. Renewal was thus assured for three years—in any event only eight new groups had put forward proposals.

The first—and only—time a full-scale renewal has taken place was in 1967. Yet the Act specifies that contracts should not exceed 10 years. Government vacillation at what to do with broadcasting has helped delay franchise allocations; there is the suspicion too that the authority has preferred not to push this requirement too hard—better the Devil you know. . . .

It is ironic in the extreme, looking back to the mid-1950s, to recall that the ITA had great difficulty in persuading people to put up bids for the early ITV contract areas. Because of what were then seen as over zealous restrictions on advertising time, and the refusal to allow sponsorship, few likely organisations expressed interest.

Perhaps it was the late Roy Thompson's remark (he wholly owned Scottish Television at the time) that ownership of a commercial television station was "a licence to print money" that did it. More probably it was the public spectacle of companies doing just that, which led to the mad scramble described by Shulman for the 1967 franchises. Whatever it was 36 groups lined up for 15 contracts—most of the interest being in the five network contracts.

In the autumn we are likely to see even more potential bidders. Over the past 25 years ITV programme companies have, with only a few hiccups, outperformed most industry. It is hardly surprising. They are a monopoly in their areas so advertisers have to use them; most of the bigger companies have used their profits to diversify into other leisure activities; quite a few of the early companies had already a large stake in the entertainment industry.

The IBA, conscious that after the debacle of London Weekend in 1968 there exists a healthy scepticism concerning its ability, plans to have public meetings in the contract areas—some are happening now—to see which way the winds are blowing. And, as I say, bidders will have to make public their promises before they are offered a contract.

Reality, unfortunately, is harsher than this, surely? For, on this matter of promises, we all know that ITV programme companies will always use the economic argument to explain why they did not, eventually, provide all that culture and public service. Unless the IBA is given instructions, and the power, to enforce penalties for a breach of contract in these matters, any amount of public posturing will come to nothing.

Is there a way to do this? Answers, please, on a postcard to the Independent Broadcasting Authority, 70 Brompton Road, London SW3. They would probably be glad to hear from you. □

TRAVEL

Wrath of grapes

Wiley Pathan

Ah, Bucharest, city of mystery, of a thousand shifting faces; city of darkness and black night where streets disappear into wasteland deserts, and buildings merge to swallow promising alleyways; city of infinite (geographical) possibilities, where one is constantly hag-ridden by the gnawing feeling that this very street was trodden not a clock-span ago, and that the people now passing are identical to those overtaken not tens of minutes

previously in another street.

Mind you, I was lost.

Or rather, as I like to think of it, playing that great game of infinite variety, Spot-the-tourist or, Getting-screwed-up-in-the-capitals-of-the-world (Waddington's and Cook's tours, from £58). It's very easy, all you need are the sort of maps thrown out in their millions by well-meaning but inefficient national tourist boards. The Canadians make daft films 10 minutes long; the Romanians make equally daft maps, 10 centimetres square and meticulously annotated with street names you never come across, showing, in precisely the wrong locations, the very monuments you never want to see. Maybe I'm jaundiced, in which case I blame the grapes (of which more later), but the Eastern Bloc countries have a talent, nay a genius, for ineptitude in all arms of government, operating at an efficiency not far above Stevenson's Rocket, and about half as modern in concept.

However, I was playing, was I not, Hunt-the-hostelry also known as Spending-an-hour-or-two-finding-a-hotel-five-minutes-away. The rules are simple, and special equipment is limited to the heaviest suitcase available filled with lead bars, or (in the event of a shortage, due to the Church Spire Target having been met) Portland cement.

Proceed at a steady pace in any direction, holding useless map the wrong way up; pass each People's Palace of Culture (three at least guaranteed) twice or more; discover that there are at last two major arteries called Karl-Marx Str., and a constellation of similarly named avenues, boulevards and plazas; in the event of finding the same square more than four times, bang head on nearest wall before proceeding; anyone not in possession of a Berlitz phrase book must throw a fit before starting; at no time collect two hundred of anything except, possibly, small stones in your sandals. (This incidentally, is how such footwear justify the title "Jesus Boots"—you know the stones are there, and you can't ignore their presence, but it's impossible to prove their existence by inspection, shaking, or thorough cleansing in the Jordan or other river.)

However, emulating Doc Holliday when his consumption was re-diagnosed as leprosy, I threw in my hand, and hurled myself screaming into the path of first taxi, the driver of which vehicle entered into the spirit and tried to run me over. After a closely fought contest with a door handle of unusually recalcitrant mien, I dragged myself, suitcase and peasant style hand-woven authentic Hungarian gypsy shawl—don't you dare forget it; Auntie Flossie's always wanted one; here's the money, don't go buying beer or slivovic with it—into the said automobile and whispered "Hotel Astoria" before collapsing like poor, punctured Hamlet.

The hotel, I need not add, was a hundred yards from the station, cunningly hidden behind a huge sign, announcing "Hotel Astoria", at a spot not at all coincident with the advertised position on the map (by now a crumpled ruin drenched in sweat and perforated with teeth-marks). I celebrated my arrival by attempting to punch out handfuls of granite from the entrance hall.

But, heartened as ever by the sight of those worse off than myself, I was able to relax and enjoy the spectacle of 14 Italians exploding in reception. As a visual display, it rivalled Chinese New Year. As it stood, it reminded me of many a French comedy (now there's an oxymoron for you!) or perhaps Mother's Day chez Capone. Between them, the Milanese and Romanian tourist bodies had got together (with a noise, one imagines, like the gear-change on a Morris Minor) and cocked up the arrangements of an entire Italian party. Eventually, one who spoke Spanish (who can figure *that* one?) sorted it out, and all went off smiling like the last page of a Noddy book, to seek food, drink, and a mutual exploration of the possibilities of sequestering certain of the French contingent.

"Food" consisted of a large, non-nutritious, but terribly good for the molars, steak, of uncertain origin. Bear in mind that we were in Transylvania. I also learned that (a) my Romanian is not up to complaining about warm salad; (b) if there is any linguistic invariant throughout man's demesne it has to be "soup's off"; and, (c) after scoffing half a ton of unwashed grapes (delivered I might add in a bunch whose shape closely mimicked that of South America, and whose size wasn't too dissimilar) the term "a night on the tiles" is transmogrified from

a narrow abstract metaphor to an excruciatingly precise physical description, rivalling the Bohr model of the atom in its accordance with experimental evidence and rigorous predictive validity.

When, however, I was finally treated to the attention of a waiter, I discovered that the hotel's entire cellar of red wine had been annexed by the Italian and French, and that I was (grudgingly) to accept a local white. For my pains I was the recipient of a fine bottle of Native Riesling. The bottle was fine, but the wine wasn't quite up to its high standard, which leads me to suppose that the Bucharestians aren't as devoid of a bit of rollicking moribund fun as I at first supposed. They now rank third in my list of sour-faced ingrates, under the Swiss (who will stare you out for hours, if they find you amusing) and the Lapps. The Lapps of course, have an excuse for stand-offishness, due to the fact that any close contact in the Tundra renders both parties firmly conjoined until the next July (try it with two ice cubes, if you can't get Lapps).

After the excellent repast as set out above, and concurrently wreaking merry havoc below, I retired to my single room, to write this timeless prose (my watch was stolen and I couldn't go to sleep as I had to be up at first sparrow's-hack to get flown, or perhaps not, to another bit of this lovely country), which I cannot post without fear of retribution. It would take too long to arrive, anyway, the post-office pony being seconded to the tourist agency for the summer to pull cartloads of postcards off to the border where they are exiled into someone else's fiscal jurisdiction. And all I can hear is the nocturnal coughing of the trolley cars below me, the cold water tap three rooms along, and the consequences of too much red wine for the Franco-Italian end of the Treaty of Rome, in practically every room except mine.

"I wonder what the pony's doing right now?" I remember thinking, before dropping into that hell-black gaping maw some call sleep, and some call guttered, awakening once to rush to the open sewer designated a lavatory, and shout for Hughie. "Hughie," I shouted, "Hughie-e-e!" □

PERSPECTIVE

Seeing through professionalism

Geoff Watts

Social workers may or may not be a good thing. It's difficult to tell. But it's not difficult to see that a degree, particularly one in sociology, is a largely irrelevant qualification. A talent for persuading the council's housing department to cut through the paperwork and fix some elderly tenant's leaking roof—which is surely what the public wants of its social workers—is unlikely to be nourished by dimly remembered undergraduate lectures on psychosocial theories of hostility patterns among children, or a system dynamics model for human resource activity. Social work is to do with high diplomacy, low cunning and sheer nous.

None of which is likely to deter the British Association of Social Workers from dreaming dreams of an all-graduate profession. Its more ardent members will continue trying to interpret the facts of their clients' lives to fit some deeply held and possibly specious social construct, while the layers of professional varnish—the alleged guarantee of good service—grow thicker by the year. The aim of the game is status. And if social workers seem of late to be collecting a disproportionate amount of stick on account of their professional aspirations, it's simply that scaling the towers of respectability is an activity that invites attention.

Social workers may be scrambling more ostentatiously than some, but they are by no means the first to attempt the Big Climb. So to redress the balance a little, let's consider a group of their relatively recent predecessors, the ophthalmic opticians.

The opticians, of course, started with two distinct advantages over the social workers: everyone knows what opticians do, and everyone can see that it needs to be done. There's no denying the value of a chap who can set you up with a comfy pair of specs that not only look good but also correct your refractive

Forum

continued

errors; nor of a chap who can yield an ophthalmoscope in search of ocular pathology that merits referral to a doctor. Such indeed are the *raison d'être* of the optician—though whether this is still apparent from the prospectuses of the half dozen universities offering degrees in ophthalmic optics, I'm not so sure.

Today's would-be ophthalmic optician (or optometrist, as the progressives are wont to call themselves) is drilled in the structure of the retina down to electron-microscope level, the detailed physiology of the secretion of aqueous humour, the latest theories on the mechanism of vision, and much more besides. All this is fine if the student wishes—as a few do—to carve a career in visual science or in industry. But most don't. They aim rather to join the Hospital Eye Service or, more likely, to set up business in the high street. Their obligation to look for signs of eye disease (as opposed to refractive malfunction) requires that they can distinguish between a healthy eye and a diseased one. But since they are not empowered to offer medical treatment, anything beyond this ability to spot right from wrong is practically unnecessary.

The undergraduate course, then, teaches the students many things they needn't know; still more perplexingly, it teaches them skills they might profitably use but don't. The student learns how to grind his own lenses, an accomplishment of some value given that the main object of the transaction between practitioner and client is usually to provide the latter with two pieces of finely-shaped glassware to balance on his nose. In practice, most lens manufacture is contracted out to prescription laboratories where rude mechanicals undertake the demeaning manual tasks of grinding and polishing.

At one time the optician was proud to see himself as a technically-skilled craftsman—as, in much of continental Europe, he remains. Across the Channel, many an optician's shop has a workroom at the back that allows the customer's lenses to be ground on the premises—so eliminating loss, breakage or delay in the post, and the many other misfortunes to which glass in transit is likely to be heir. But, you may say, for an expensively-trained optician to be grinding lenses, or even supervising technicians in his workshop, is a shocking waste. To which I reply: the simplest way of minimising the waste is not to overtrain the man in the first place. Sadly, European opticians too have now caught the professional bug and, encouraged by their brethren in Britain, are moving in a similar direction. As a sometime member of that elite corps of two or three full-time writers who constitute the ophthalmic optical press, I now cringe to recall how I once penned pompous editorials egging on the nascent European professionalism.

Despite the codes of conduct, the ethical standards, the noisy huffing and puffing about this, that and the other, whole chunks of professionalism are nothing more than disguised systems of restrictive practice and other self-serving arrangements in which the customer/client/patient is but one consideration, and not necessarily the first. The opticians' beloved professionalism lies uneasily with the awful reality that his standard of living depends to a significant extent on whatever flair he has for flogging expensive private frames. And professionalism certainly doesn't breed efficiency. A couple of years ago, a colleague broke his spectacle lenses two days before leaving for a trip to Singapore. By luck, he managed to find one of the vanishingly small number of London opticians who are still geared up to grind their own lenses. Yet on arrival in Singapore he stumbled on a street with a whole row of (highly professional) opticians' shops in any one of which his needs might have been met (unprofessionally) on the premises and within hours.

Incidentally, one of the partners in the London practice that did help him out was an Indian. □

WESTMINSTER SCENE

Keep on truckin'

Tam Dalyell MP



I anticipate a good deal of trouble over tachographs. On 7 February, the European Court of Justice announced its decision on the European Commission case against the United Kingdom over the implementation of the Tachograph Regulation No. 1463/70. The regulation requires the use of tachographs in most goods vehicles over 3.5 tonnes gross weight, and in buses and coaches not on regular services. It was accepted by the

United Kingdom when we joined the Community, and there was no subsequent attempt to renegotiate it. However, although in 1977 parliament approved regulations enabling the tachograph to be used on a voluntary basis, the government has not previously believed it necessary to make the use of the tachograph compulsory. It has now considered the decision of the Court that the United Kingdom is in breach of its obligations under the Treaty of Rome. Bill Rodgers told James Johnson (Kingston-upon-Hull) that the government had "reluctantly concluded that it must accept the decision". Rodgers is to open consultations shortly with the employers' organisations and the trades unions on an appropriate time-table to achieve full implementation of Regulation 1463/70. He is consulting the Commission as he is obliged to do under the terms of the regulation. He will also lay the orders to be debated in the House of Commons.

Some MPs feel that the real trouble lies in the regulations for lorries, which were understandable at the time when they were imposed, but are now somewhat outdated. In the past 10 years, many motorways and bypasses have been constructed, which make it much easier to measure distance by mile or kilometre. Even more important, the ability of vehicles to brake, in some cases on the proverbial sixpence, has made it much safer for drivers to go at speeds which wise drivers 10 years ago would not have considered at all safe. Even at this late stage, MPs hope that some kind of compromise is reached—otherwise the issue will be a live one when it comes to direct elections for the European parliament to be held on 7 June.

The question of cadmium has received a good deal of strident publicity in the press. Austin Mitchell (Grimsby) asked the Department of Environment ministers whether they have any proposals to check cadmium levels in sewage sludge used as fertiliser. Denis Howell said that his department's interim guidelines on the disposal of sewage sludge to land, published in 1977, include recommendations on the limits of application of cadmium and other elements to agricultural land. Such application is dependent on analyses of the sludges, and in some cases of the receiving soils, being available to water authorities. The DoE has instigated and is sponsoring research on the uptake of cadmium by crops to review safety margins and is cooperating with the Department of Health and Social Services on epidemiological surveys of the health of people eating vegetables grown on cadmium-contaminated soils. Howell pointed out to Mitchell that the highest levels of cadmium at Shiphams in Somerset are higher than any previously reported; but "they had been brought to light by a uniquely thorough geochemical survey". He added that emissions to air and water from the United Kingdom's single zinc refinery were monitored by the appropriate statutory authorities. Emissions from copper and lead smelting were considered to be too low to give rise to any general environmental problem. The general view among MPs is that the scare-mongering on the part of sections of the press about Shiphams has done nothing but harm to the serious environmental lobby that is concerned about water supplies. □



#EYTON



Review

The roots of human nature Two views

Beast and man

by Mary Midgley, Harvester Press, pp 377, £7.50

1. In this book a moral philosopher looks at human nature in evolutionary perspective. Accepting that we are here through evolution by natural selection, Mary Midgley tackles the question "How can man best live? To what way of life is he best adapted?" There is surely room for a bridge between moral philosophy (in which psychology had its roots) and evolutionary biology. Edward Wilson, in *Sociobiology* and his recent *On Human Nature*, has laid abutments on the biological side, and they have been built on by other sociobiologists. Midgley comes from the other side, but can hardly be said to meet the sociobiologists in midstream.

The author agrees with Professor Wilson that much of our nature is genetically determined (that we are born creatures of instinct, not blank paper to be imprinted by culture), but criticises his deification of the gene, and his expectation of a scientific psychology. Apart from Wilson, Midgley's main biological sources are semi-pop ethologists—Konrad Lorenz, the Eibl-Eibesfeldts, Jane Goodall, Desmond Morris. That team hardly measures up, in length or strength, to the philosophical tradition behind the author of *Beast and Man*.

I found the book both dense

and discursive, yet it is written with terrific style, and is full of wit and sharpness. Midgley has plenty to say about purpose, motives, freedom, culture, conscience, language and other knotty problems. Yet her general conclusions seemed to me much what one would expect from the premise that we are shaped by natural selection. For the view that human nature is adaptive is bound to lead towards "all is for the best". Ten years ago, Michael Ghiselin wrote: "There is some hope that in the future a genuine reconciliation between psychological and evolutionary thinking may be effected." If sociobiology is the best attempt from the evolutionary

The talks are reprinted here.

Given the relentlessly churning world of political movements for independence, the gap between rich and poor, science and technology bashing everyone's head and pocket, missiles and nuclear weapons, the lecturers were asked to say what they thought the salient features were and what changes might take place in the next two decades. More, how could bludgeoned humanity cope with them? Security was taken to mean more than mili-

side, Mary Midgley's book is a noble beginning from the older tradition. *Colin Patterson*

2. Mary Midgley has produced a book that is at once witty, provocative, illuminating, and wrong. She seeks to use the new biology—behaviour and evolution—to re-assess moral philosophy and the nature of man, and, for those less aware of philosophy than biology, she succeeds. It is a shame that her biology is not, at times, the equal of her philosophy; the biological sources are often idiosyncratic, patchy, and partially discredited. But her philosophy seems to contain much that is sensible. There is the awful possibility that other philosophers will take the biology as gospel and regard the philosophy as suspect.

The problem, for me, is that although I have never thought about it in quite the same terms, the notion that man differs from brute not so much in kind as in degree is obvious. And I think the same would be true for most bio-

logists. Philosophers obviously have more time to worry about such things, and came up with all manner of diverse systems which, finally and seemingly irrevocably, set man firmly on the pedestal where he so plainly belongs. Midgley shows how this attitude was shaped by other factors in society—what isn't—and also explains the various systems rather well.

I am left wondering just who, if anyone, the book is aimed at. Most biologists that I know would be annoyed by the mistakes and take the conclusions as given. And philosophers haven't spent all this time worrying about morals to be led astray by so simple a thing as evolution. That leaves the man in the street, who is neither a trained biologist nor a philosopher—but he's uniquely equipped to do both, as Midgley emphasises. I confess that I have no idea what he will make of this book, but I hope he will read it as I am sure he will get something out of it over and above a good, stimulating read. *Jeremy Cherfas*

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World change

and world security

MIT Press, pp 206, \$14.95

In the winter and spring, 1976-77, the Massachusetts Institute of Technology celebrated 200 years of United States history in its own way by inviting 10 of the world's intellectual and political leaders to lecture. They included familiar names—Roy Jenkins, Willy Brandt—and the less familiar—Canon Burgess Carr and Frank Church.

Review

continued

tary security, encompassing human happiness, physical and mental well-being.

A tall order. The trouble with change is that it goes on increasing its speed. The lectures give the impression now of people running for a bus, managing to cling on with one hand, but doomed to being dragged off their feet. It's no fault of theirs. There's no driver of the damn thing.

It wouldn't be true to say that we've heard it all before, but the lectures suffer inescapably because it's so much easier to point out problems, *appalling* problems, shameful inequalities and des-

perate hypocrisy than it is to figure out practical ways of dealing with them.

Is there really any hope of stopping the arms race? The birth rate? Aggression? Is it really possible for the human race to evolve fast enough to be able to deal with its own ingenuity? Reading the lectures, which is occasionally something of a chore because there are lecturers' idioms and tricks that translate unhappily to print, is likely to be depressing. Stand to the salute of moral values while the water in the sinking battleship gradually creeps up.

Roy Herbert

IC schematic sourcemaster

by Kendall Webster Sessions

Wiley, pp 557, £19

Anyone who finds himself overwhelmed by the number of integrated circuit devices available today will probably welcome this book. It is a compilation of 1500 schematic diagrams of electronic circuits, using integrated linear and

digital devices, together with some discrete components.

The book is divided into 16 sections, each dealing with broad classes of circuits such as communications; analogue and digital converters; automotive circuits and active filters.

All the circuits are reproduced from manufacturers' data books and application notes. The text with each diagram is limited and in some cases insufficient to explain the function. The sources of the information are usually recognisable but are not referenced.

Photographic reproduction of the original schematic is used to eliminate errors and almost succeeds. The text, however, below the caption "Self zeroing operational amplifier" on p 72 is applicable not to that diagram but to the one below, and the upper diagram on p 73 should be captioned "Chopper amplifier". Many schematics which are identical or have only minor differences are repeated. A stereo-amplifier diagram is repeated no less than five times. This repetition is evident in the section devoted to active filters, where the design expressions are given incongruously for an elaborate fourth order elliptic filter but not for the simple second-order Sallen and Key filters shown.

This is not a book for the electronic engineering specialist who will have access to the original sources. The most attractive feature of the book is that so many topics are accessible within a single volume. Thus the most likely purchaser is one with limited library facilities wishing to browse through a large variety of diverse circuit functions.

Alan Blackburn

Careering forwards

If you really haven't thought hard about which lucky employer is to have you once you have graduated, or qualified, then a booklet to start you thinking about **Careers in science and technology** has been published by the National Advisory Centre on Careers for Women, 251 Brompton Road, London SW3 2HB. That it comes from an organisation advising on women's employment should not detract from its usefulness to men. It is packed with good sound advice and provides an admirable introduction to science-based careers. Its aim is to start young people thinking about their future. At £1.80 it is a true bargain. Any family with a budding scientist or technologist should have a copy.

Now that a science background is viewed by most employees as part of an individual's general education—just as traditionally they have for history and the classics in the past—it is helpful to get a feeling of the sort of competition that you may encounter when you apply for various occupations. For this you may have to turn to more comprehensive guides, such as *Cassell's careers encyclopaedia* (now in its 9th edition, £9.50) or Haymarket's *Directory of opportunities for graduates* (DOG 79, £8.50, but free to all students in their last year), or New Opportunity Press's *The good job guide* (£2.95). *Cassell's* is full of good sense and its coverage is all embracing.

Haymarket's DOG 79 contains a 500 page guide to employers, and good indexes to occupations, employers' activities, degree subjects, and the regions. All said, it is a directory, but a very useful one because of its indexes. This year it also contains a special focus on scientists, contributed by John Delin, who is information and publications officer at Loughborough University, and *New Scientist's* education correspondent. It also includes features on "Mature students—problems of employment", "How to handle a handicap", "Change of direction", and "Research: rewarding and relevant" (the last mentioned by Peter Gardner, a research physicist for ICI).

The annual guide to employment opportunities from New Opportunity Press is also a mixture of directory, gazetteer and, in the current issue, contains contributions on "Why change your job?", "Where to

look for a job", "Postgraduate and professional qualifications" and "Job trends". Of the two directories, though, DOG is the more comprehensive.

If you are determined to take up a specialist career, the Careers Research and Advisory Centre issues a range of detailed guides through Hobson's Press, Cambridge. *Agricultural Science*, *Biochemistry*, *Biological Sciences*, *Geological and Environmental Sciences* are just a few of the titles costing between £1 and £1.50.

Future, "the magazine for graduates and their employers", is a bold new venture from the Graduate Publishing Division of New Opportunity Press (annual subscription £3.50 for 12 issues). The first issue has been dogged by industrial action, and so it is impossible to comment fairly on the likely usefulness of this venture. The two lead contributions look at "Careers in 2001". The crystal balls that they peer into seem to be videoscreens. The main conclusions drawn are that temporary work will become the major growth industry, that loyalty to one employer will be eroded, and that "there will be more skilled and fewer unskilled jobs. Good education and good training will take on an increased premium".

The first number of *Future* also assesses a recent survey into graduate supply and demand—"output of mechanical and civil engineering is rising strongly. Output of the other branches of engineering shows little change, but it has stopped declining." Two other articles include a report of the recent meeting of the long-awaited "Recruitment Society" in London, and the first of a regular "Working abroad" feature, which reviews a survey issued by Overseas Recruitment Services. *Future* issues are to carry "10 years ago—my future as I saw it then", and "Reading the employer's thoughts—a study of recruitment advertising". Both are features denied to readers of issue No 1 by industrial action—something that could make the basis of an article on it's own in the *Future*?

Richard Fifield

Studies in Biology Competition

Applicants are reminded that the closing date for submission of entries is
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LC#78-22122, ca 375 pp. To be released March 1979.

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LC#78-22121, ca 250 pp. To be released in February, 1979.

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LC#78-10115, 161 pp., October 1978.

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LC#78-00882, 748 pp., October 1978. Available in England from: Abacus Press, Spelthurst Road, Uxbridge, Middlesex, U.K.

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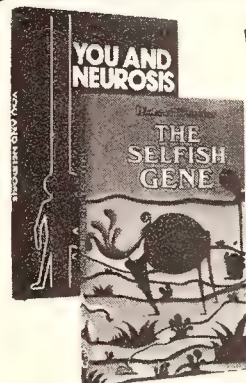
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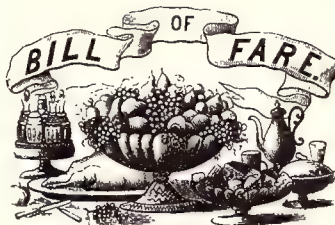
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Review

continued



Human nutrition

Readings from

Scientific American

W. H. Freeman, pp 275, £8.75,

ppb £4.60

In the United States, both the president and Congress have identified nutrition as an area "for extreme concern" and "immediate action". This preoccupation at high governmental levels with what Americans eat culminated, last year, in the famous McGovern statement setting out dietary goals for Americans. But there is evidently also a broader interest in how the Western world is going to help solve the problems of world hunger. In August 1977, President Carter's guidelines for organised federal action in nutrition stated clearly that there should be "more carefully targeted nutrition research" to improve the food supply at home and throughout the world.

Against this backdrop of obsessional concern with food and diet at home and malnutrition abroad, *Scientific American's* latest collection of papers on human nutrition is a readable and welcome addition. It is ideal not only for students of home economics and nutrition but for general readers who want to go beyond the fad diet books in their concern to know how we are to achieve a balanced diet for the world's millions.

The monograph is at pains to place the discussion on human nutrition in a world context. Papers not only get down to the cellular level to discuss cell energetics and photosynthesis, but there is also up-to-date discussion of the broader issues of the prospects of plant and animal breeding for providing more food. Another paper admirably reviews the complex theories motivating research into the mechanisms of nitrogen fixation. Particularly interesting is the potential use of genetic manipulation tools to foster the ability of nitrogen fixation on cereals, thus lessening the world's dependence on ex-

pensive fertilisers. Another section muses delightfully on the effect of salt and potatoes on human behaviour, in particular exploring the movement of people around the world in response to food pressures.

The last section on the global problem of human nutrition explores many thought-provoking issues about population growth and orthodox and unorthodox ways of producing more food. It doesn't mention one little-publicised problem, the difficulty of assessing the extent of chronic malnutrition in developing nations, where reliable statistics are rare.

Unfortunately, the standard of photographs and diagrams does not measure up to the high quality of the writing. Some figures are uninformative and obscure and the pictures unimaginative. In a book of this type designed to reach a large public audience more attention should have been paid to this aspect of its production. *Stephanie Yanchinski*

Trace metals in the environment: volume 3—

Zirconium

by I. Smith and B. Carson

pp 405

Volume 4—Palladium and Osmium

by I. Smith, B. Carson and

T. Ferguson pp 193

Ann Arbor Science, £15.20 each

Sulphur in the environment

edited by Jerome Nriagu

Wiley-Interscience

Part 1, pp 464, £23

Part 2, pp 484, £24

These four books, reviewing the environmental significance of four elements, are good examples of a trend that has now established itself—of examining the totality of the science of one element. That trend indicates the growing complexity and density of data collected on environmental pollutants. Increasingly, the crux of so many environmental problems is not the lack of data, but a lack of any coherent guide to action. Of course, there are still gaps in knowledge. No one really knows, for example, exactly how sulphur dioxide and other

air pollutants exert the medical effects that have shown up in so many epidemiological surveys.

But reviews such as these—comprehensive, tackling every link in the chain between an element's natural occurrence and its effect on man, animals and plants—show how much has been learnt.

The two volumes on sulphur examine its occurrence, use, behaviour in the atmosphere, and effects on plants and man. It has shied away from looking at specific control measures to prevent sulphur pollution (there are, in any event, a number of books on this topic).

The books on zirconium, palladium and osmium are similarly thorough. They grew out of a grant from the US National Institute of Environmental Health Sciences to the Midwest Research Institute.

All four books are dense with fact. The reviews of particular areas of science, whether analytical chemistry or toxicology, are precisely

the kind of introduction an outsider needs. Even more helpful are the links that the reader can make. It is simple enough, for example, to leap from the toxicology of sulphur dioxide to a chapter on its long-range transport. No doubt, individual reviewers (especially in the multi-author work on sulphur) have their own quirks and biases. But in such a rich review of research there are plenty of observations to support your own interpretation.

Lawrence McGinty

Cosmic search

Cosmic Quest Inc

\$18 per year for 6 issues

Twenty years ago an article in *Nature* pointed out that our radiotelescopes are suitable instruments for communicating over interstellar distances. It started off a flurry of activity that has not yet subsided. *Cosmic Search*, a bi-monthly American magazine, recently published for the first time, is the latest product of this

space-age interest.

The journal is devoted to the search for extraterrestrial intelligence (SETI) and its proclaimed purpose is to present, in a popular and responsible manner, all aspects of the search for intelligent life in space. The editorial board contains many eminent astronomers and reads like a "Who's Who" of SETI.

The 50 or so pages of text include numerous features, such as a brief introduction to the basic philosophy behind SETI, a short glossary, a review of current news, a useful booklist, and some cartoons. The articles impressed me most. Although not all of them were written specifically for the magazine, they present a balanced and readable set of opinions on SETI.

The first issue includes a reprint of the original *Nature* article by G. Cocconi and P. Morrison accompanied by a "Twenty years on" feature by Philip Morrison. Frank Drake reminisces about Project Ozma, which in 1960 was the first unsuccessful attempt to

detect artificial radio signals. There is a charming article by Jocelyn Bell-Burnell in which she talks about the discovery of pulsars and the headaches caused by their possibly artificial origin. Another article asks "What if we succeed?", and Arthur C. Clarke wonders why 25 per cent of the bright novae between 1899 and 1936 appeared in only 0.25 per cent of the sky.

Future issues, we are promised, will contain articles on gravitational waves, extraterrestrial politics, and an interview with G. K. O'Neill on space colonisation and SETI. It is encouraging to see a scientific and responsible magazine aimed at satisfying popular interest in SETI.

David Whitehouse

Spineless mistake

The book mentioned on p 270 of the 25 January issue should have been entitled *Invertebrate Palaeontology and Evolution* not, as was published, *Invertebrate Palaeoanthropology and Evolution*. Apologies to the author.

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Opening a copy of The Weekly Educational Review is like opening the door of a crowded noisy common room. Inside, you'll find all the topics that *really* concern teachers these days—pay claims, politics in education, keeping the staff happy, school size, examinations, bringing back the cane, streaming versus non-streaming. They're all there, discussed with an openness, an insight, a critical intelligence

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The Weekly Educational Review

Teachers' Pay Claims

Review

continued



Heritage Dinosaur relationships

Dinosaurs are among the most popular exhibits that can be offered by any natural history museum, and popular books on dinosaurs sell in their thousands. The main appeal of the subject is to the 8-15 year-olds, although for a few academics it may extend well into senility. From the popularity of the subject, and the ready availability of information, it would seem reasonable to assume that most museum visitors come with a clear and accurate concept of "dinosaurs". Alas, this is not so. When questioned, most visitors identify almost all large extinct vertebrates as dinosaurs. The reasons for this common misconception lie in some serious flaws in museum exhibitions and in almost all popular books on the subject.

First, many of the popular books on dinosaurs are written by academics whose own understanding of the group rests on a vast body of knowledge, but which is often ill-defined or poorly organised. Such writers frequently assume a similar sort of understanding on the part of their readers, and simply do not see any need to define or to explain

the group. Secondly, the books and museum exhibits deal with the anatomy, body temperature, ecology, etc and pay scant attention to basic facts about the group with which they are dealing. In contrast to this, Alan Charig in his new and outstanding book, *A New Look at the Dinosaurs*, states: "I have assumed that my typical reader is supremely ignorant of dinosaurs and related matters; or, if he has

lot of new information. From the several approaches possible we chose to deal with the relationships of the dinosaurs. The alternative, "ecological", approach has great appeal and several of our critics claim that this is the one we should have taken. Unfortunately, it has several weaknesses not the least that it leads to a series of isolated statements such as: "*Tyrannosaurus rex* was the largest flesh eater of all

mation lacked overall structure. Any diversity display must fulfil two specific aims: it must show the range of characteristics in a group and it must show the limits of that group. Most existing diversity displays in museums fulfil the first aim but give little attention to the second. Planning the redisplay of dinosaurs therefore concentrated on the two general aims of correcting misconceptions and imparting new knowledge about dinosaurs, and the specific aims of showing dinosaur diversity and establishing the limits of the group "dinosaurs".

The first of the specific aims is fulfilled simply by showing as wide a range of dinosaurs as possible. The exhibition includes five mounted dinosaur skeletons—*Diplodocus*, *Triceratops*, *Iguanodon*, *Gallimimus* and *Hypsilophodon*—the skull of *Tyrannosaurus* and a large block containing the skeleton of *Scolosaurus*. The second aim is far more difficult to fulfil, but it provides the conceptual framework on which the visitor can build supplementary information on dinosaur natural history that is presented with the specimens and the accompanying book that will be published this summer*.

The identification and defini-

Even before opening its replanned display of dinosaurs London's Natural History Museum was faced by a barrage of criticism. Here we invite one of its organisers to explain the thinking behind the new exhibition

learnt something, that which he has learnt is wrong or out of date." Charig lives up to this statement. He devotes several pages to clear explanation of the terms dinosaur and Dinosauria, and shows what is included in the group and what is excluded. He carefully explains the characteristics and problems associated with the grouping.

When we set out to replan the display of dinosaurs at the British Museum (Natural History) we accepted that most visitors would have serious misconceptions about dinosaurs. Moreover, we realised that many visitors would want to learn about these fascinating fossils. So with careful treatment, we could impart a

time; the ceratopsians were the very first palm wine drinkers; *Ornithomimus* may have eaten eggs." All very interesting, but not inspiring and without any structure. Certainly not anything that a modern scientist would be proud of!

In contrast, a treatment of the relationships of the dinosaurs can rely on specimens and objective interpretations from them. It is an approach that has not been attempted before, either in popular book or exhibition form. This was the approach we chose.

The late lamented display of dinosaurs at the Natural History Museum was essentially a display of dinosaur diversity but the accompanying infor-

* *Dinosaurs and their Living Relatives* (British Museum (Natural History)).

tion of the group dinosaurs is approached in two ways. One set of exhibits contains specimens and explanations of the main animals, and attempts to correct any misconceptions by discriminating between the "dinosaurs" and "non-dinosaurs". (The other vertebrate groups dealt with in these exhibits are the ichthyosaurs, plesiosaurs, fossil amphibians and fossil birds.)

The second approach explains why a fossil may be identified as a dinosaur and how scientists assess its relationship with other dinosaurs. This section provides most of the information that will be new to the visitors. Exhibits in this section are sequential and outline the concepts on which assessments of relationships are based. They also show how biologists identify a specimen with a particular group.

The sequence of exhibits is introduced through basic concepts such as evolution, speciation, characteristics and similarities. The visitor is then invited to assess the relationship between several vertebrates using various characteristics.

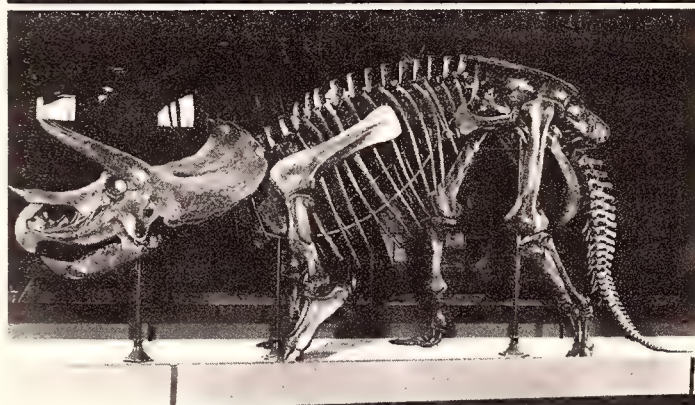
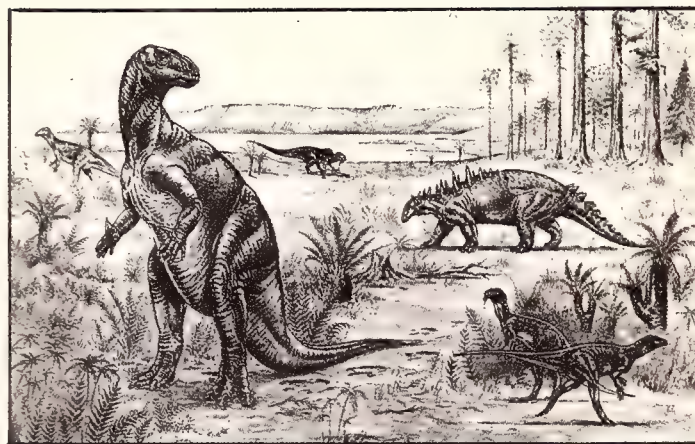
As a general principle, "the present is the key to the past". To provide a framework on which we can place the dinosaurs we must, therefore, first review living groups that could be closely related to them. Features of the membranes that surround the developing fetus are characteristic of turtles, lizards and snakes, crocodiles, birds and mammals but are not found in other vertebrates. These animals can therefore be grouped together. Details of the skull indicate that birds and crocodiles are more closely related, and the dinosaurs, flying reptiles (pterosaurs) and *Euparkeria* (representing the Thecodontia) share these features.

These animals are therefore closely related and are placed in a group called the archosaurs, which is a valid clade (see Figures 1 and 2). Other important groups including turtles, lizards and snakes, mammals, plesiosaurs and ichthyosaurs are excluded from this group.

Relationships may be somewhat unclear in the Archosauria but several familiar dinosaurs have characters that are not found in other archosaurs. *Triceratops*, *Iguanodon*, *Hypsilophodon* and *Scolosaurus* have a special bone—the predeontary—at the front of the lower jaw. This indicates close relationship between these dinosaurs and is characteristic of the "bird-hipped" or ornithischian dinosaurs, so Ornithischia is a valid clade.

Turning to the other dinosaurs, however, a different situation is revealed. *Tyrannosaurus*, *Diplodocus* and *Gallimimus* are used in the exhibition. These and many other dinosaurs are usually grouped in the Saurischia using as a character the shape of the pelvis, but surprise, surprise, *Euparkeria*, pterosaurs, crocodiles, turtles, lizards and even mammal-like reptiles also have a pelvis of the saurischian shape. The pelvis cannot therefore be used as a unique character and no other character has been found that can be used to group the saurischians together. This suggests that the Saurischia is not a valid clade but is a rag-bag group of Jurassic and Cretaceous archosaurs whose only feature in common is that they were not ornithischians, crocodiles, pterosaurs or birds. This is not a valid way to form a group but perhaps it accounts for the failure of authors and museum exhibits previously to explain the limits of the group Dinosauria; because the group is indefinable.

If we look at individual "saurischians", however, it is possible to identify related forms. For example, features of the pelvic girdle (pubis) sug-



Above Dinosaurs of 115 million years ago. Left *Iguanodon*, right *Hypsilophodon*, and immediately behind *Polacanthus*. Below The newly positioned *Triceratops* Opposite Dinosaurs of 65-70 million years ago. Clockwise from the bottom left: *Ornithomimus*, *Pachycephalosaurus*, *Anatosaurus*, *Triceratops*, *Tyrannosaurus*, and *Euoplocephalus*

gest that *Tyrannosaurus* and *Gallimimus* (and another bipedal dinosaur—*Deinonychus*) are more closely related to each other than to *Diplodocus*. Features of the wrist also suggest that *Deinonychus* and the earliest fossil bird *Archaeopteryx* are closely related; so the birds are closely related to some of the animals that we call dinosaurs. This means that the classical idea of the dinosaurs (Dinosauria) is only tenable if the birds are included. But we cannot validate the group Saurischia and cannot establish relationships with the Ornithischia. Therefore, as Charig suggests, it may be necessary to include the crocodiles and pterosaurs which would make the Dinosauria and Archosauria synonymous. Not much future in this: the

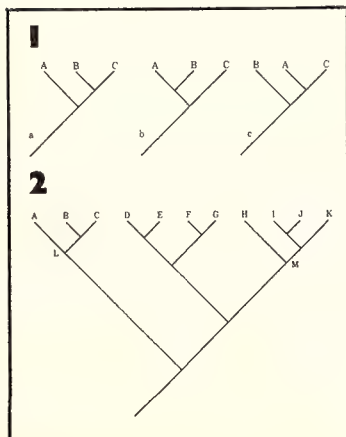
group Dinosauria seems to be taxonomically extinct.

This part of the exhibition is for the more interested and knowledgeable visitors and it may get less gut reaction than the constant blood-letting and swamp wallowing that characterise the "ecological" approach. We think however that our approach provides the necessary framework in which the visitor will be able to understand more clearly information on dinosaur natural history.

We have attempted to lead our visitors to the point where problems over dinosaur physiology, relationships and ecology can be understood when they are encountered in books or on television. Only response from our visitors will tell us if we have succeeded. We hope that for the first time a dinosaur exhibition will communicate appreciably more than is summed up in the frequently heard "Cor int' they big". We and the visitors already know that.

Roger Hamilton

Dr Hamilton is a member of the Department of Public Services at the British Museum (Natural History).



If species arise as a result of one species splitting into two new ones then for three contemporaneous species A, B and C, two must be more closely related to each other than either is to the third (Figure 1). B and C form a valid grouping or "clade" and only valid clades (Figure 2) should be used in taxonomy. They must include all the descendants of a common ancestor and only those descendants. In Figure 2 groupings ABC and HIJK are valid. DEF is not valid as it excludes G. ABCD is not valid as it includes D. These principles of systematics represent a methodology that taxonomists have applied since Darwin

Letters

Select few

I read with some interest Michael Kenward's Comment (1 March, p 650) on the question of House of Commons select committees in which he refers to my own views on this matter.

He implies that the work which has for the past 13 years been carried out by the Select Committee on Science and Technology—of which I have been a member for some time—would not be adequately covered by a departmental select committee covering the Department of Education and Science; but, of course, no one is suggesting that it would.

As I pointed out in my speech in the debate, the various subjects which the Select Committee on Science and Technology has explored over the past 13 years could be covered adequately by departmental Select Committees for Education and Science, and Industry and Energy. In point of fact, a very considerable amount of the time of the Science and Technology Committee has been taken up with energy matters over the past few years, and it has produced important reports on nuclear power, off-shore oil, conservation, and renewable energy resources. It would be reasonable to assume that this kind of work could be adequately and efficiently discharged by the proposed new departmental Select Committee covering the work of the Department of Energy—it would certainly not fall to the Select Committee for the DES.

Similarly, some of the

investigations undertaken by the Science and Technology Committee have had a direct bearing on industrial problems and on matters which could in future quite properly be dealt with by the proposed departmental Select Committee for Industry.

So far as a departmental Select Committee for Education and Science is concerned, I explained in the debate that I would envisage that this committee, like all the others, would create sub-committees to deal with particular areas of policy and expenditure and I would assume that at least one sub-committee would be created which would have as its special task surveillance of scientific matters as opposed to issues concerning primary and secondary education. Incidentally, I do not share Michael Kenward's airy contempt for the investigation of educational problems below the rarefied levels of scientific research.

What I do find puzzling is that a contributor to *New Scientist* should prefer the muddled *ad hoc* incoherent hotch-potch of committees which the House of Commons uses at present, to proposals for a coherent and systematic committee structure for the investigation of government activities.

Frank Hooley
House of Commons London

Scottish pollution

The Scottish Wildlife Trust has been receiving disturbing reports from its members in Orkney and Shetland about recent widespread increases in apparently small-scale oil

pollution incidents, which are causing an insidious build up of oil on all the beaches including those on such isolated islands as Fair Isle and Sule Skerry.

From the results of analysis so far much of this oil would appear to be North Sea crude oil, and not the bunker oil spilt in Sullom Voe. It may well be that unscrupulous tanker masters are taking advantage of the recent oil spill to wash out their ballast tanks, confident that their contribution to the general chaos will pass unnoticed.

At present there is no ballast water treatment plant at Sullom Voe: it is not expected to be completed before May. In the meantime the Northern Isles are bearing the consequences of this mismanagement.

Last week Orkney Field Club members, working on the east coast beaches, cleared up over 2 tonnes of oil in tacky lumps ranging from egg-sized to 25 kg, but light enough to be re-distributed with every high tide. The shore-breeding birds will soon be returning to their nesting areas, and other animals including sheep (on islands like North Ronaldsay) which feed almost entirely on seaweed, and otters travelling across the shore, are at risk.

The system is obviously not working properly, and the present situation would seem to warrant some emergency interim measures. If the temporary closure of Sullom Voe is not considered possible, the port should accept only tankers with segregated ballast water storage vessels until the plant

is operational. There should be routine testing of ballast water from tankers, to identify the origins of any subsequent oil slicks, and the system for analysis should be speeded up. Something must be done now, or the natural environment of the Northern Isles may never recover.

Margaret Makepeace
The Scottish Wildlife Trust
Edinburgh

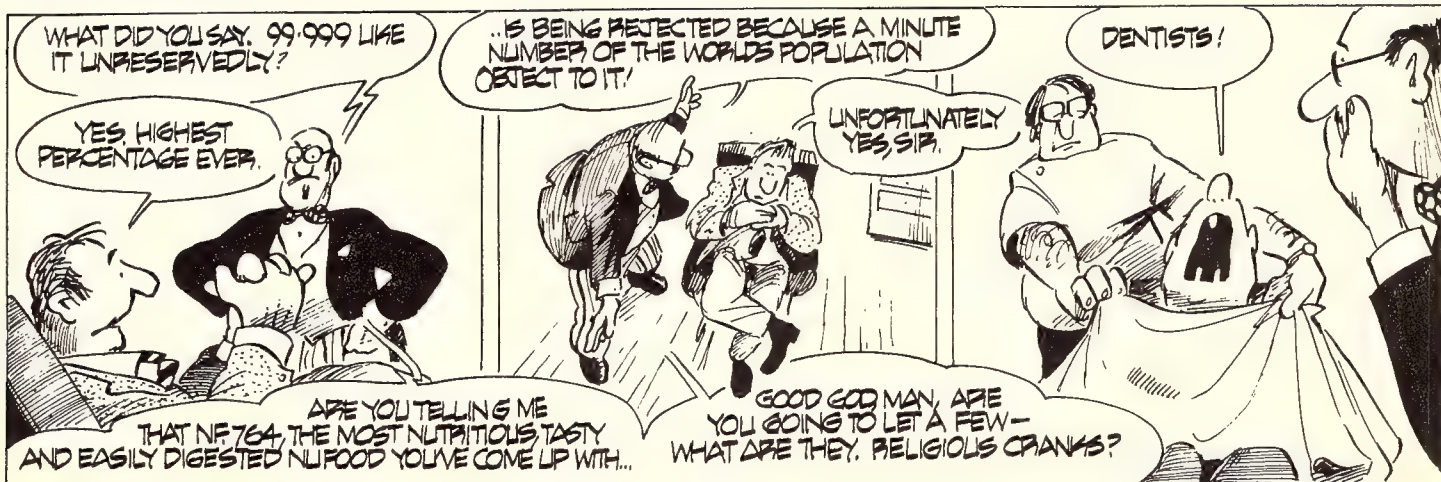


Clever sheep

After the recent arctic weather conditions we have been through, I would like to invite comment on some observations I have made. The observations concern the behaviour of the herd of Gritstone sheep resident in Lyme Park in Cheshire. The amount of snow we have experienced has restricted grazing and I have seen the sheep scratching the snow away with their forelegs to reveal the hidden grass. I

Grimbledon Down

Bill Tidy



have also observed the use of "tools" for this purpose—pieces of wood held in the incisor teeth, used especially where snow has thawed and refrozen becoming hard and icy. The sheep have also been left concentrated feed blocks which, when frozen, become difficult to bite and chew. They also hold these blocks in their teeth and abrade them on the icy snow.

Has anything like this been observed before? Is "tool" using among wild or domesticated ruminants a common characteristic?
S. F. Bates Cheshire

Gay explanation

May I support your author of "Gay start to liver vaccine trial". Unlike J. Robertson (Letters, 1 March p 708), I quite understand the gist of the article.

Homosexual men are at recurring risk of acquiring hepatitis B for a variety of reasons, not yet fully understood, but which must include frequent partner-changing within a group containing large numbers of asymptomatic carriers of hepatitis B virus. Homosexuals are particularly aware of this problem associated with their way of life and probably fear it more than syphilis. They realise that at present hepatitis B is neither treatable nor preventable—at least the latter may be put to right and they will cooperate as best they can.

Notwithstanding, there will be a considerable drop-out of patients as one finds in all projects on patients with sexually transmitted diseases, and this has been allowed for in the original numbers entered in the trial.

Paul Simmons
St Bartholomew's Hospital
London

In response to J. Robertson I would suggest there are several good reasons for reporting that the first volunteers for trials with a new hepatitis vaccine were gay men.

1. Gays who undertake to test out any new drug or vaccine are unlikely to have children or want to produce them.

This lack of dependents means that if any inherent risks in the trial actually materialise, only those volunteers suffer. We are as

interested in improving human society as any heterosexual person is.

2. The only publicity given to homosexuality is all too often the details of criminal court cases. Imagine trying to make sense of heterosexuality from such proceedings. The misleading impressions of gays that the media generally feeds to the general public will be dispelled only once all aspects of homosexuality—both good and bad—are openly discussed.

3. The facts as reported were true. Any deliberate non-mention of the interesting and newsworthy fact would have been a case of unnecessary self-censorship.

We scientists are concerned with seeking out truths and not ignoring or covering up those which we may not like. I hope *New Scientist* will continue to fully reflect life as it is irrespective of how unpopular it might become in so doing.

Peter Cromwell
Campaign for Homosexual
Equality Leicester

Silicon gamble

In his article "Britain takes a silicon gamble" (15 February, p 470) Peter Laurie asks why GEC is going back into business with Fairchild to make microelectronics when I said in 1971 that microcircuits "had become a commodity which could be bought competitively like any other in the open market".

The statement which he quoted referred to standard digital logic microcircuits. Since then GEC Semiconductors has developed and manufactured specialist circuits, for example for pushbutton telephones, teletext and viewdata, for both GEC units and other customers. In the same period GEC units have bought standard logic microprocessors, and memory circuits on the open market from a variety of suppliers.

At the beginning of 1978 we became aware that Fairchild was proposing to build a new plant for standard metal oxide semiconductor circuits, similar to its South San José plant, and was considering the advantages of siting the plant in the United Kingdom. At the same time GEC was finding increasing demand for the "equipment and

- ENIGMA -

No. 4

Die balancing

Stephen Ainley

The die shown is of the ordinary kind; on the hidden faces, 6 lies opposite 1, 4 opposite 3, and 2 opposite 5. But it doesn't roll true. The dots marking the numbers are little gold spheres, and their weight tends to make the larger numbers end up at the bottom when the die is rolled.

I have some spare little gold spheres, and I want to balance the die by gluing them at suitable vertices or mid-edges—places like those marked with empty circles in the picture. Naturally, I want to use as few as possible. And I should like (if it doesn't cost me any extra spheres) to put one at vertex 1/4/5.

Where should I glue them on? (For convenience, call the mid-edge between faces 4 and 5 "4/5", the vertex surrounded by faces 1, 4 and 5 "1/4/5", and so on.)

Answer to Enigma 3

Cricket

| | |
|---------------------------|---------------------------|
| A v B won on 1st innings | B v C lost on 1st innings |
| A v C lost on 1st innings | B v D tie |
| A v D won | C v D tie. |

A £5 book token will be awarded to the sender of the first correct solution opened on Wednesday, 21 March. Please send entries to *New Scientist*, King's Reach Tower, Stamford Street, London SE1, marking the envelope *Enigma*. The editor's decision is final. The winner of Enigma No 2 (Roots), was T. Lookman of London.

industry" circuits which it had developed and made. GEC also needed access to the equipment which is normal in a competitive American mass production plant for work on some of its advanced devices. The needs of Fairchild and GEC were therefore complementary and led to the decision to establish the GEC-Fairchild manufacturing plant at Neston.

The process plant and equipment in the factory will be based on Fairchild's latest technology. The standard microcircuits, such as memories and microprocessors, will be designed by Fairchild.

GEC Semiconductors will continue to develop equipment and industry circuits, some of which will be wanted in very large quantities. When they are based on the process technology in the GEC-Fairchild plant at Neston they can be made in that plant. They will continue to be sold through GEC.

If circumstances showed that we should alter a decision

made eight years ago, we should certainly change it, but in this case we can see no inconsistency between our actions in 1971 and 1978.

R. J. Clayton
Technical director
GEC London

No take-over—yet

Your item "New life for artificial intelligence" (Technology, 1 March p 676) referred to the new expert consultation systems as "replacing people". The pattern so far has not been along this line: instead, the human experts have been enabled to extend their own expertise and hence the interest of their work and their own value. In one case the gain in human skill (at diagnosing soy-bean diseases) was attributable to the human expert's adoption of an improved classificatory system which had been elaborated for him by his machine partner. Far from being replaced, Dr Jacobsen, the plant pathologist at the University of

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continued

Illinois who collaborated with
the computer program in the
experimental trials, is an
even more highly valued
professional man now than
he was before!

Donald Michie
Edinburgh University

Science courts

I find myself most unhappy
about Lord Ashby's assertion
that he is not attacking the
Science Court (Letters, 22
February, p 595). It seems to
me that he is turning the
idea upside down by asserting
that it should replace political
decisions on non-factual
issues. We would be acquiring
an institution that would
have all the tyrannical
overtones of the technocracy
of the 1930s. I am completely
opposed to this move.

Secondly, Lord Ashby talks
about scientific questions
being "resolved" by the
Science Court. It was never
proposed that the Science
Court could resolve issues,
creating knowledge where it
doesn't exist. This is the
function of scientific research,
not the Science Court. The
function of the Science Court
is to provide a credible
statement of what is known
and of what is not known at
a time when political
decisions must be made.

Arthur Kantrowitz Cambridge
Massachusetts

IBM speculators

Your story "IBM tackles its
imitators" (15 February,
p 482) implies that IBM will
soon be announcing further
machines in the IBM 4300
series. Your reporter is of
course free to speculate, but
I should emphasise that we
have given no indication of a
future announcement of this
kind.

The 4331 can be used in an
office environment; the 4341
needs air conditioning.

A. B. Cleaver

IBM

Portsmouth

Babies

I was intrigued to see how
closely Rosenblatt, Redshaw,
Packer and Lieberman
("Drugs, birth and infant
behaviour", 15 February
p 486) replicated, with much
better data and a bigger
sample, the findings reported
by myself and my colleagues,
and by Judith Bernal (now
Dunn). The St Mary's group
reports that "a high number

of non-optimal factors—
ranging from the mother's
smoking, being single, or
being under 18 or over 35, to
the use of forceps and
induction—was related to
more frequent waking at
night, at least up to 12
months". Our finding was that
the same count of "non-
optimal" factors associated
with more frequent waking
at 15 months old. Richards
and Bernal reported that night
waking at 14 months was
associated with long labour
and poor respiratory status at
birth. They also report the 14-
month-old night wakers as
being more "active" and
wakeful in the first 10 days
of life. The St Mary's group
finds something very similar:
"infants who were more
active and changeable in
their first week were . . .
more likely to wake at night
up to one year". With the far
inferior measure of a
summary score of a mother's
retrospective answers to
questions about several
specific aspects of her child's
behaviour as a newborn, we
found the same association
with later night waking. In
Richards and Bernal's sample,
and in our sample, the night
wakers continued to be
difficult about sleep until 2-3
years old and a number of
other aspects of later
behaviour differentiate
between night wakers and
good sleepers, or between
children of optimal or sub-
optimal birth histories.

It is unfortunate that instead
of announcing their success
in demonstrating, with a
better designed study, that
there is at least one
replicable finding in
developmental psychology
that concerns behaviour of
real importance to parents,
the St Mary's group
invented and then criticised
conclusions that do not exist.
I did not conclude that the
administration of analgesics
during labour had lasting
effects on the child, nor that
interventions by obstetricians
were anything other than
evidence that there probably
were indications for such
intervention.

In short, our evidence
supports the conclusion of
the article but, at risk of
endangering our friendship, I
protest against the authors
for selecting me for the
"opposing team" against my
will and without good reason.

The unfortunate result is that
they present their field of
research, which has quite
surprisingly consistent findings,
as being divided and
inconsistent.

N. G. Blurton Jones
Institute of Child Health

London

In their article Deborah
Rosenblatt and colleagues
make a number of
observations about our work,
directly or by implication,
which we feel demand
comment.

1. In our sample we showed
that the drugs given to a
mother in labour were not
related to her medical
condition.

2. Our study did concern
Pethilorfan (pethidine and
levallorphan) not pethidine
alone. Though it is obviously
important to investigate the
effects of single drugs, it is
also vital to know something
about the effects of the
combinations of drugs which
are widely used as
interaction effects are
commonplace.

3. We never claimed any
association between night
waking or sleep disturbance
and the use of drugs in
labour.

4. We have never suggested
that analgesic drugs "can
drastically alter the behaviour
of mother and child". The
effects were small, but they
persisted beyond the period
for which the drugs or their
metabolites were detectable
in the baby's bloodstream (an
important consideration in
both neonatal and adult
psychopharmacology).

5. Undoubtedly some parents
have been made anxious by
reports of the hazards of
obstetric intervention.
Sensationalised and inaccurate
writing has not helped but
let us hope that it will not
be the case in future, as it
was in the instance of
pethidine, that compounds are
used for a quarter of a
century before any attempt is
made to investigate their
effects on mother and infant
behaviour. We fully recognise
that the methods which we
used in the mid 1960s can be
greatly improved. But we
make no apology for the
fact that our studies served to
call attention to the
behavioural effects of drugs
in common use.

Martin Richards

Judy Dunn

Cambridge

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The appointment, which is financed by the SRC, will be for one year in the first instance, commencing on 1 October, 1979, and will be on a salary up to £4382 per annum, together with USS/USDPs benefits.

Informal enquiries may be made to Professor Pelter, Department of Chemistry, but application forms (2 copies) and further particulars should be obtained from the Registrar, University College of Swansea, Singleton Park, Swansea SA2 8PP, to whom they should be returned by Friday 13 April, 1979.

UNIVERSITY OF BRISTOL

School of Veterinary Science

Department of Animal Husbandry

There is a vacancy in the above department for a

Research Assistant

to study the environment in calf rearing units. The project will involve analysis of the factors which affect heat and water exchange and the spread of aerosols and bacteria. Applicants should have, or expect to attain this year, a degree in veterinary science or a good honours degree in agriculture.

This project will be supported for three years by the Agricultural Research Council and the appointee will be expected to register for a higher degree. The initial salary will be £3384 per annum (scale under review).

Applications, together with a curriculum vitae and the names and addresses of two referees, should be sent by 31 March to Professor A. J. F. Webster, Department of Animal Husbandry, Langford House, Langford, Bristol BS18 7DU, from whom further particulars may be obtained.

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The Wellcome Research Laboratories,
Langley Court, Beckenham, Kent BR3 3BS.



IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Biochemistry POSTDOCTORAL RESEARCH ASSISTANT

required to join a group involved in Genetic Manipulation of Industrial Microorganisms for new fermentation processes. Experience in some aspects of recombinant DNA technology would be an advantage. The appointment is available from 1 October, 1979 and would be for two years in the first instance on the scale £3883-£6555 plus London Allowance, £450 per annum.

Applications including a curriculum vitae together with an indication of relevant experience and future aspirations for research should be addressed to Professor B. S. Hartley, FRS, Department of Biochemistry, Imperial College, London SW7 2AZ.

UNIVERSITY OF LONDON Institute of Neurology RESEARCH ASSOCIATE IN BIOCHEMISTRY

required to undertake research and development into assays for prostaglandins in brain, by GLC-mass spectrometry and radio immunoassay, in collaboration with the University Departments of Chemical Pathology and Neurosurgery. It is hoped that a suitable candidate could present the work for a PhD.

The post is for two years commencing as soon as possible. Salary (with London allowance) depends on age, experience, and qualifications. Applications to Secretary, Institute of Neurology, The National Hospital, Queen Square, London WC1N 3BG.

THE OPEN UNIVERSITY FACULTY OF TECHNOLOGY



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Applicants, preferably aged 25-35, should have a good honours degree in a relevant branch of engineering or science such as electronics, computing, control, cybernetics or physics, and some teaching, research or industrial experience. They should also have the ability to communicate by the written word.

The post initially involves contributing to the writing and maintenance of courses in electronic systems and communications. Later there will be the opportunity to contribute to interdisciplinary courses in the Faculty, such as those concerned with the social and economic aspects of technology, energy conversion and engineering design. An interest in the broader aspects of technology will therefore be an advantage.

Applicants will be expected to carry out research in their field of interest. Current research in the Faculty covers a wide range of subjects including, instrumentation, microprocessor applications, telecommunication systems for distance learning, energy research and alternative technology.

Salary will be within the range £3883-£7754 pa (under review).

Application forms and further particulars are available, by postcard request please, from **The Recruitment Office (MH3295/4), The Open University, PO Box 75, Walton Hall, Milton Keynes MK7 6AL or telephone Milton Keynes 63868 (24 hour answering service).**

Closing date for applications: 16 April.

THE EDINBURGH SCHOOL OF AGRICULTURE

UNIVERSITY OF EDINBURGH

DEPARTMENT OF AGRICULTURAL BIOCHEMISTRY

RESEARCH ASSISTANTS

Two Research Assistants are required to work on

(1) The biochemical aspects of the nitrogenous changes during the ensilage of grass
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(2) Nitrogen metabolism in young chicks consuming microbial protein and nucleic acids.
(Ref ARC/19NS)

Candidates should have a good Honours degree in Biochemistry, Biological Sciences, Agricultural Science or equivalent.

Salary initially £3384 per annum.

Application forms and further particulars can be obtained from the **Secretary, Edinburgh School of Agriculture, West Mains Road, Edinburgh EH9 3JG.**

Closing date for receipt of completed applications—7 April, 1979.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY LONDON LECTURESHIP IN BIOCHEMISTRY

A vacancy exists for a Lectureship in Biochemistry in the general area of Applied Microbial Biochemistry. Applications from those with interests in the expression of Eukaryotic genes in *E. coli* for the potential production of medically or industrially useful proteins will be specially welcomed. The Department is fully equipped for the most modern techniques relevant to these interests.

Salary will be within the range £3883-£7754 (under review), plus £450 London Allowance and is subject to USS.

Applications, which should include a curriculum vitae, the names of three referees and a statement of future research plans, should be sent to Professor B. S. Hartley, FRS, Department of Biochemistry, Imperial College of Science and Technology, London SW7 2AZ.

UNIVERSITY OF NOTTINGHAM

School of Agriculture

TEMPORARY LECTURESHIP IN SOIL SCIENCE

There will be a vacancy for a Lecturer in Soil Science in the Department of Physiology and Environmental Studies. The appointment will be for two years from 1 September, 1979, with a possible extension for the third year, and it will be made in the first three steps of the Lecturer Scale.

The main emphasis in the Soil Science Section relates to physical and chemical aspects of soil/plant relationships and it is expected that the person appointed would strengthen these interests: research experience is desirable.

Further particulars and forms of application, returnable not later than 23 March 1979, from the Staff Appointments Officer, University of Nottingham, University Park, Nottingham NG7 2RD. Reference number 675.

**MEDICAL RESEARCH COUNCIL
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**Systems Analysts/
Programmers in Data-Base-
Management and Real-Time
Computing**

Applications are invited for **two** posts in computing at the Headquarters of the Institute of Hearing Research in Nottingham, to commence as soon as may be arranged. The Institute has a multidisciplinary research programme that requires (i) sophisticated real-time process-control in biomedical and psychological applications, and (ii) statistical data processing and management of clinical data. Nominally, one post will be allocated to the former area and one to the latter although combined responsibilities may be given to a suitable appointee. A PDP11/60 computer system with graphics satellite and various microcomputer sub-systems are being installed. Appointees will play major roles in bringing these systems into use.

Applicants should possess an honours degree and have programming experience. For the real-time post, either the degree or the practical computing experience should be in a scientific or engineering subject. Experience and interest in the following areas will be an additional advantage: data-base management, statistical computing, real-time laboratory computing, digital signal-processing techniques, PDP11 systems, microprocessors, simulation, emulators, graphics and networking.

Appointments will probably be made on the Research Officer, or Senior Research Officer, scales (£3582 to £4902 and £4971 to £6294) (under review), according to age, qualifications and experience. However, an appointment could be made carrying additional managerial responsibilities on the administrative scale (£6293 to £7454) (under review).

Further details of both posts and application forms may be obtained from Mrs J. Willoughby: Telephone: (0602 782203). Completed applications should reach **The Director, MRC Institute of Hearing Research, D81, The Medical School, University of Nottingham, Nottingham NG7 2UH**, by 26 March, 1979.

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Naturally you must have experience in this field of work and be the holder of the appropriate City and Guilds qualification. But if you hold a full Technological certificate in one or more aspects of the areas concerned it will of course be to your advantage.

The salary is up to £3651 (inclusive) but there is a qualification allowance for those suitably qualified.

If you would like to find out more about this very interesting vacancy why not write for an application form to **The Chief Administrative Officer, Dorset Institute of Higher Education, Wallisdown Road, Poole**. Please quote post no: HEB 61. Closing date 29 March.

Information Scientists

Beecham Pharmaceuticals Research Division has a substantial commitment to information services which are in a phase of expansion. An opportunity has now arisen for two Information Scientists to join established Information Services teams.

One post is for an Information Scientist to work with research projects dealing with the broad areas of immunology and allergy. These research projects are at present based at Brockham Park near Dorking, Surrey but will relocate later this year to our recently acquired Biosciences Research Centre at Great Burgh, near Epsom. The second post is for an Information Scientist to serve the information needs of research projects working in the field of antimicrobial chemotherapy and will be based at Brockham Park. In both cases the Information Scientist will be expected to work closely with the research scientists. On-line computerised literature searching will constitute part of the job.

A degree in a biological science or biochemistry is essential for the first post and degree in chemistry or biochemistry for the second. Experience of, or a qualification in, information science is also desirable as is membership of the Institute of Information Scientists.

The Company offers a competitive salary, non-contributory pension, free life assurance, flexible working hours, 20 days holiday, good sports and social facilities etc. Free transport is provided to and from local stations.

Please apply to:

Miss E. A. Gunn, Site Personnel Officer, Beecham Pharmaceuticals, Research Division, Brockham Park, Betchworth, Surrey RH3 7AJ.

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**PAISLEY COLLEGE
DEPARTMENT OF PHYSICS**

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Applications are invited from graduates or non-graduates with experience of glass melting procedures, to prepare high purity luminescent glasses.

Depending on age, qualifications and experience, the starting salary will be in the range £4000 to £5000 pa.

Applicants should write to **Dr A. R. Spowart, Senior Lecturer, Department of Physics, Paisley College of Technology, High Street, Paisley PA1 2BE**, with career details including the names of two referees, by 30 April, 1979.



SCIENCE RESEARCH COUNCIL

Computer Programmers for Research

APPLETON LABORATORY has vacancies for COMPUTER PROGRAMMERS to work on data processing and control in support of a major International Satellite project, the Infra Red Astronomy Satellite (IRAS), which will be launched in February 1981. The Science Research Council has the responsibility for providing the satellite control centre and a scientific data analysis centre for this project which is a collaborative venture with the United States and The Netherlands. The main computers that will be used are two PDP11/35 machines and a large ICL mainframe. Programmers are needed in the following areas:

- real-time software
- large-scale data base handling
- orbit and attitude analysis
- scientific data processing

Posts will be available at both Scientific Officer and Higher Scientific Officer level. Applicants should have a degree, HND, HNC or equivalent qualification in Science, Mathematics or Computer Science, with at least two years' programming experience for the higher posts.

The posts will initially be located at Ditton Park, Slough but will probably be transferred later to Chilton, Oxfordshire.

Salary will be on the following scales (Outer London Weighting Allowance included), the exact step depending on qualifications and experience: £4376-£5723 for an HSO or £3114-£4690 for an SO.

Non-contributory pension scheme.

Please request an application form from: **The Secretary, Science Research Council, Appleton Laboratory, Ditton Park, Slough SL3 9JX. Tel. Slough 44234, Ext. 153. Closing date: 5 April, 1979.**

UNIVERSITY OF READING LECTURESHIP AT THE NATIONAL COLLEGE OF FOOD TECHNOLOGY

Applications are invited for a Lectureship, tenable at the National College of Food Technology, Weybridge, from persons with qualifications and experience in applied microbiology preferably of particular relevance to the food industry. The successful candidate will be expected to contribute to teaching at undergraduate and postgraduate levels and develop an experimental research programme. Opportunities for research are available in all aspects of food microbiology.

The appointment will date from 1 October, 1979.

Further information may be obtained from the Registrar (Room 214, Whiteknights House), The University, Whiteknights, Reading RG6 2AH, by whom applications should be received not later than 30 April, 1979.

INSTITUTE OF CANCER RESEARCH

There is a vacancy for a
TECHNICIAN

to work in the Radiotherapy Research Laboratories at Sutton in a research programme on in vitro tests for the sensitivity of human tumour cells to cancer chemotherapeutic agents. The work involves specialised tissue culture techniques as well as some laboratory animal work with xenografted human tumours. Experience in pharmacology would be an advantage. The appointment will be on the Technician scale which starts at £3261 per annum plus London Allowance of £354 per annum.

Applications in duplicate with the names of two referees to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting reference 301/B/62.

THE NATIONAL HOSPITALS FOR NERVOUS DISEASES Queen Square, London WC1N 3BG require a

Junior Medical Laboratory Scientific Officer

to undertake duties in routine Clinical Pathology. Training will be given primarily in Haematology but the successful candidate will have the opportunity to gain experience in all four Departments of the Laboratory. Preference will be given to candidates who are currently studying for ONC or who plan to do so and have 5 'O' levels, to include two science subjects, English Language and Mathematics, or two appropriate 'A' level passes. For further details contact **Mr D. Warner, Senior Chief MLSO. (01-837 3611 ext 52).**

Applications, giving the names and addresses of two referees, should be sent to the **Personnel Officer** at the above address.

AGRICULTURAL RESEARCH COUNCIL INSTITUTE OF ANIMAL PHYSIOLOGY BABRAHAM, CAMBRIDGE CB2 4AT

Scientific Officer

required in the Endocrine Laboratory of the Department of Applied Biology. The research involves biochemical analytical methods; experience with such techniques and an interest in electronics would be an advantage. Applicants should have a pass degree, HNC or equivalent in a relevant biological science. Salary in scale £2839-£4415 pa according to qualifications and relevant experience. Non-contributory superannuation scheme. Application form and further details may be obtained from the **Secretary of the Institute. Quote Ref. DRB2. Closing date 30 March, 1979.**

**WELSH NATIONAL SCHOOL OF
MEDICINE**
Department of Medicine
and
UNIVERSITY COLLEGE, CARDIFF
Department of Biochemistry

TWO POSTDOCTORAL RESEARCH OFFICERS

Applications are invited for two Research Officer positions, one to work with Dr John Kay at University College, Cardiff and the other with Dr R. Marks, Reader and Consultant in Dermatology, Welsh National School of Medicine, on a collaborative project to identify serum component(s) of possible importance in wound healing. The work in the first post will include large scale fractionation of human serum while the second will be involved with assay systems, organ culture and histometric techniques.

Candidates for the first position should have, or expect to obtain shortly, a PhD degree in Biochemistry or a related subject and research experience in protein purification systems, especially affinity chromatography and ultrafiltration procedures, would be an advantage. For the second post, a PhD in Biochemistry or other biological discipline would be acceptable and experience with histological procedures and tissue culture systems would be advantageous.

The appointments, which will be for one year in the first instance (renewable for a second year), are financed by a grant from the Medical Research Council. Starting salaries up to £3883 per annum (under review).

Applications in the form of a curriculum vitae, with the names and addresses of two referees, should be sent to the **Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff** within 3 weeks from the date of appearance of this advertisement (quoting ref no M6/53).

UNIVERSITY OF DURHAM Department of Physics

POSTDOCTORAL SENIOR RESEARCH ASSISTANTSHIP IN PHYSICS

for two years, starting as soon as possible after 1 April, 1979, to work in collaboration with the Max Planck Institute for Radioastronomy in Bonn on the interpretation of the Galactic Continuum Radiation. Candidates should preferably have experience in cosmic rays, plasma physics or radio astronomy and an interest in computing.

Initial salary in the range £3883-£5129 (under review), plus superannuation.

Applications (three copies) naming three referees should be sent by 31 March, 1979 to the Registrar and Secretary, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

UNIVERSITY OF CAMBRIDGE

Department of Clinical
Veterinary Medicine

BACTERIOLOGY TECHNICIAN GRADE R7

Applications are invited from persons with HNC (bacteriology), AIMS (bacteriology) or MI Biol., for post at grade R7 (£3190-£3838 under review) financed by a three year grant starting this year. The work involves research, preparation of practical classes for veterinary students and some diagnostic bacteriology, and provides an opportunity to become expert in the bacteriology of animal diseases. Applications stating age, qualifications and experience, with the names of at least two referees should be made to the Departmental Secretary, Department of Clinical Veterinary Medicine, Madingley Road, Cambridge.

Designing tomorrow's gas turbines in Bristol

Rolls-Royce has had a record sales year, with deals signed in 1978 that could be ultimately worth more than £2,000 million.

To maintain our worldwide technological lead and to further increase our penetration of international markets we are now looking for talented men and women to work on projected designs for civil and military applications here in Bristol.

You will be entering a highly sophisticated environment, where the ultimate in technical resources are immediately at your disposal, and where personal development and training programmes are considered of major importance - factors that make a Rolls-Royce Designer internationally respected.

Engineering Design

Engineering Design at Rolls-Royce is a key function demanding conceptual thinking, innovation and creativity along with a good knowledge of current and future technology.

The Designer's task is to produce schemes from which detailed manufacturing drawings can be prepared. The Designer

uses information from specialist areas such as Stress, Aerodynamics, Heat Transfer, Metallurgy and Combustion in order to define the 'best' concept to produce a competitive product despite the conflicting requirements of high performance, long life, low cost, low weight. . . This synthesis is an essential and satisfying part of design at Rolls-Royce.

We would like to hear from men and women with a Degree, HND or HNC ideally combined with practical experience. Several years relevant design experience, possibly gained in the aircraft, turbine or motor industries could be an acceptable alternative to these qualifications.

Our Remuneration Policy

As a high technology business we reward our people well for high performance through an individual award system in addition to annual salary reviews.

A generous relocation package to Bristol is available and house prices are considered reasonable.

Fill in the check list and send it to us Freepost - we'll be in touch.

| | | |
|---|--|---|
| <input type="checkbox"/> Degree <input type="checkbox"/> HND <input type="checkbox"/> HNC <input type="checkbox"/> OTHER SUBJECT _____ _____ | NO. OF YEARS EXPERIENCE: 0-1 1-2 <input type="checkbox"/> <input type="checkbox"/> 2-3 3+ <input type="checkbox"/> <input type="checkbox"/> | JOB SPECIALISATION EMPLOYER'S PRODUCT NX/49 |
| NAME _____ AGE _____ ADDRESS _____ _____ | | TELEPHONE NUMBER DAY EVENING |

Maurice Cromwell, Rolls-Royce Limited, Aero Division, FREEPOST,
P.O. Box 3, Filton, Bristol BS12 7QE.



AERO DIVISION

Come with us into the 21st century

Senior Toxicologist

Ford Motor Company wish to recruit a science graduate with wide relevant experience and who is accustomed to considerable responsibility in this field. A medical qualification would be an advantage.

The main duties of the position will be to review and advise upon the toxicological aspects of both production and non-production materials. The successful applicant, who will be based at the Research and Engineering Centre at Basildon in Essex, will report to the Company's Chief Medical Officer and will work closely with the Company's Senior Medical Officers and Hygienists.

A salary commensurate with these responsibilities is offered, together with fringe benefits that would be expected of a large and progressive Company.

Please write giving full details of qualifications and experience to:

**Mr G H Channing, FRCS, Chief Medical Officer,
Room 1/162B, Ford Motor Company Limited,
Eagle Way, Warley, Nr Brentwood, Essex.**



UNIVERSITY OF SOUTHAMPTON

**Department of Biochemistry
School of Biochemical and
Physiological Sciences**

**Synthesis of Novel Antibiotics
RESEARCH ASSISTANT/
FELLOW—SYNTHETIC
ORGANIC CHEMISTRY**

Applications are invited for a research assistant/fellow to participate in a programme of work directed towards the synthesis of novel antibiotics. The vacancy will suit an organic chemist with a PhD degree but chemistry graduates wishing to move into the area of bio-organic chemistry are encouraged to apply.

The position, which in the first instance is for a one year appointment, is available immediately.

Starting salary up to £4382 per annum, depending on qualifications and experience. USS benefits.

Applications giving date of birth, curriculum vitae and the names and addresses of two referees should be sent as soon as possible to Mrs P. Vaughan-Smith, The University, Southampton SO9 5NH, quoting reference 1057/NSc.

TECHNICIAN (GRADE 4)

required in Department of Linguistic Science, Phonetics Laboratory, University of Reading. The Laboratory is used for speech research and undergraduate teaching and is equipped with a wide range of instrumentation and assistance in research and development. Good electronics background desirable and interest in audio-recording and development work. Salary in scale £2955-£3402 per annum (under review). Apply, quoting reference T.S. 19A, with full details of qualifications and experience and names of two referees, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.



National Research
Council Canada

Conseil national
de recherches Canada

SOLID STATE EXPERIMENTALIST

The Solid State Chemistry section of the Division of Chemistry, Ottawa is widening its programme of basic studies of metals, alloys and metallurgical phases to include noncrystalline conductors, composite metal/insulators, granular metals and sputtered mixtures or phases. The group has a vacancy for an experimentalist with experience in some of the above areas to follow assigned and self-initiated projects that match the interests of the section. Applicants should have a PhD in physics, chemistry or materials' science with specialisation in the solid state, and should include a summary of their proposed research. Salary will depend on qualifications and experience.

NRC

Apply in writing to the **Employment Officer, National Research Council of Canada, Ottawa, Ontario, Canada K1A 0R6** including full details of education and experience and the names of two referees, before the end of **May 1979**. In reply please quote **C-196**.

INSTITUTE OF CANCER RESEARCH TECHNICIAN

required at the Chester Beatty Research Institute, Fulham Road, London SW3 to assist in studies on the development of systems for the delivery of toxic agents to specific targets. Candidates should possess an HNC, a university degree or equivalent in biochemistry. Experience in column chromatography and electrophoresis would be an advantage. The salary will accord with MRC scales in the range £3261-£4680 per annum plus £354 per annum London Allowance.

Apply in duplicate with the names of two referees to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting reference 501/B/60.

GIBRALTAR POINT NATURE RESERVE, Lincs.

INTERPRETIVE OFFICER

required April to October Interpretation to visiting parties, general public, mounting guided walks, information etc.

Summer Warden required April-end July for wardening shore-bird colonies. £20 per week. Accommodation.

Further details for both the above posts SAE the Conservator, L&SHTNC, The Manor House, Alford, Lincs.

FRIENDS OF THE EARTH BIRMINGHAM

Urban Nature Conservation

Dedicated naturalist, with ability to communicate, required for two year urban nature education project. Salary c. £2200. Further details and application form from FoE (Birmingham), Allison St., Birmingham B5 5TH. Applications by 31 March.

Development Chemist West Midlands to £6,000

ELEY is a leading world producer of sporting and rimfire ammunition, part of the IMI group of companies.

Based in Birmingham, they now wish to strengthen their development team by the appointment of an experimental chemist. Your key role will be to generate and subsequently be responsible for development projects from initial feasibility study through to full production. Often open-ended in nature these projects involve close liaison with technical and production staff and you must therefore be able to communicate effectively your project recommendations.

You are likely to be 25-45 and educated to degree or equivalent level, although proven project ability and a mature and innovative

approach to problem solving is of overriding importance.

Similarly whilst experience with explosives is highly desirable, a practical (rather than research-oriented) background in general chemistry - ideally with an engineering end-product - is looked for. It is this awareness - of the need for a profitable outcome - that will characterise the successful candidate. This position represents the ideal opportunity for someone who is both career-minded and capable of working on their own initiative. If your qualifications and

experience are matched only by your drive and enthusiasm, you can expect to receive an attractive salary plus excellent fringe benefits, including relocation where appropriate. For more information and an informal interview, contact Robert Harvey on 021-233 1101 (021-784 5454 out of hours) or write to him at

The Personnel People,
Coleridge Chambers,
177 Corporation
Street,
Birmingham,
B4 6RG.



The Personnel People
Specialists in Executive and Technical Recruitment
London, Hertford, Birmingham, Edinburgh,
Glasgow, Brussels, Dusseldorf.



INSTITUTE OF CANCER RESEARCH TECHNICIAN OR JUNIOR TECHNICIAN

required for the electron microscope department at the Chester Beatty Research Institute, Fulham Road, London SW3. Experience in a biological electron microscope laboratory is desirable but candidates with experience in biochemical techniques or histopathological methods will be considered. The salary will accord with MRC scales in the range £1905-£4680 per annum plus £354 per annum. London Allowance.

Apply in duplicate with the names of two referees to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting reference 301/B/61.

LABORATORY SCIENTIFIC OFFICER

required as soon as possible for work on a three-year research project, supported by the Medical Research Council, examining the effect of steroids on experimental and human immune complex disease. Techniques used will include basic immunochemical methods, analytical ultracentrifugation, tests of macrophage function and electron microscopy. Salary for qualified Laboratory Scientific Officer not less than £3261 plus £354 London Weighting.

Apply in writing, stating age and giving details of qualifications and experience, to the Secretary, Guy's Hospital Medical School, London Bridge SE1 9RT, quoting reference RUI.

INSTITUTE OF CANCER RESEARCH TECHNICIAN

required at the Sutton, Surrey laboratories for work with mammalian cell culture applied to radiobiology. Applicants should have a degree, HNC or equivalent in a relevant subject. Experience in cell culture methods would be an advantage but is not essential. Salary in range £3261-£4680 per annum plus London Allowance of £354 per annum (MRC Technician scales).

Applications in duplicate with the names of two referees should be sent to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU, quoting reference 301/B/59.

ANALYST-PROGRAMMERS for Drug Research

We have two vacancies in the Section which has the function of providing a computing service to our Pharmaceutical Research and Development Laboratories. The Computing Section is at the start of a period of development and new implementations are planned in the following broad areas:

- on-line data capture from safety evaluation experiments
- interactive information (text) retrieval
- managements of structured experimental data, including its interfacing to application programs
- network analysis and project management

The computing facilities available will include an ICL 2960 and DEC PDP-11 equipment.

Applications are invited from programmers and systems analysts, ideally science graduates, who have some experience working with one or other of these machines, or have knowledge of some of the applications described. For the maintenance of existing systems it would be desirable for one of the posts that the person concerned has experience of COBOL, and usefully also of FILETAB and COIN. Initially, the people appointed would be involved in evaluating alternative means for implementing the applications outlined above, and subsequently they would carry through implementations up to and including hand over to user and maintenance.

The benefits of working for Fisons include flexible working hours, an active Sports and Social Club and pension facilities. An attractive salary, depending on experience, is offered and assistance with relocation where appropriate.

**Applicants (male or female) please write to Mr Bryan Johnston, Fisons Limited—
Pharmaceutical Division, Bakewell Road,
Loughborough, Leicestershire LE11 0QY.
Tel 0509 66361. Please quote ref no 968R/NS.**



PHARMACEUTICAL DIVISION

UNIVERSITY OF EXETER School of Education (Heavitree Road, Exeter) SCIENCE TECHNICIAN

Applications are invited for a Science Technician for duties which will be primarily in Physics as assigned by the Senior Technician. Main duties include preparation of laboratories for teaching; organisation of laboratory use; repair, manufacture and maintenance of apparatus; demonstration of apparatus and general assistance to students.

Applicants should preferably hold an appropriate City and Guilds Intermediate Certificate or equivalent, and have relevant experience.

Salary scale £2688-£3060 per annum, initial placement dependent on age, qualifications and experience.

Letters of application, stating age, qualifications, experience and the names of two referees to Miss Doreen Watson, Northcote House, Exeter EX4 4QJ, by 22 March, 1979. Please quote reference number 8670.

THE UNIVERSITY OF HULL Department of Physics

A vacancy exists for a GRADE 3 TECHNICIAN

The successful applicant will be responsible for duties in a Teaching Laboratory under supervision of Academic Staff. Duties will involve the setting up and maintenance of experiments and servicing of equipment. Minimum qualifications: ONC or equivalent and at least three years relevant experience. Salary on the scale £2688-£3060 per annum (under review).

Applications, giving details of age, qualifications, experience and the names of two referees should reach the Technical Staff Officer, University of Hull HU6 7RX, by 23 March, quoting reference number TP/1.

ELECTRONICS TECHNICIAN (GRADE 5)

with appropriate qualifications and experience required in Physics Department. Salary scale (under review) £3651-£4185 including London Weighting. Permanent pensionable post. Apply, stating age, qualifications and experience to Administrative Assistant, (NS) Birkbeck College, Malet Street, London WC1E 7HX or Tel: 01-580 6622 ext. 271 for application forms.

OVERSEAS DEVELOPMENT

KNOW-HOW: vital to developing countries

Coffee Specialist

Thailand

Responsible for coffee programme and determining suitable areas for coffee plantations and nurseries. Supervising Establishment and subsequent management of plantations and providing specific training in coffee production. Applicants should have degree in Natural Science plus relevant experience. Age 35-60.

Appointment 2 years. Salary (UK taxable) in range £8100-£10 250 pa plus overseas allowance in range £1390-£3085 pa. (Ref 331).

The post is wholly financed by the British Government under Britain's programme of aid to the developing countries. In addition to basic salary and overseas allowances other benefits normally include paid leave, free family passages, childrens education allowances and holiday visits, free accommodation and medical attention. Applicants should be citizens of the United Kingdom.

For full details and application form please apply, quoting reference stating post concerned, and giving details of age, qualifications and experience to:—



Appointments Officer,
MINISTRY OF OVERSEAS DEVELOPMENT,
Room 301, Eland House,
Stag Place, London SW1E 5DH.

HELPING NATIONS HELP THEMSELVES

PUBLIC HEALTH LABORATORY SERVICE BOARD

**MICROBIOLOGIST—
BASIC GRADE
GRADUATE ELECTRON
MICROSCOPIST**

Applications are invited for the post of electron microscopist in the Public Health Laboratory & Dept of Microbiology, Central Middlesex Hospital, London NW10. This post offers opportunities to develop electronmicroscopy diagnostic techniques in clinical virology and other aspects of microbiology. In addition to a service commitment, the person appointed will be expected to undertake research work and to teach electronmicroscopy to members of the laboratory staff and others as required. Participation in other aspects of virology may be required on occasion. Applicants should possess a first-class (or upper second class) honours degree or higher qualification in microbiology.

NHS terms and conditions of service. Salary scale £2991-£4899 + £354 London Weighting.

Closing date 5 April, 1979.

The laboratory may be visited by arrangement with the Director, Dr D. A. McSwiggan, 01-965-1603, to whom an application (giving curriculum vitae together with the names and addresses of three referees) should be sent.

Directorate of Scientific Services

Fisheries Assistant

Salary Scale Maximum £3500 pa

Two Fisheries Assistants are required to take part in the Thames Salmon Rehabilitation programme, and will be based at Reading. The work is scientifically orientated and will entail the assessment of potential salmon spawning and nursery areas; the monitoring of stocked juvenile salmon, and the operation of a temporary fish trap on a Thames weir. Applicants, who should be able to drive a car, and swim, will probably be biological graduates with an interest in working outdoors. Relevant experience would be an advantage.

Starting salary dependent upon age, qualifications and experience.

Application forms available from the Assistant Director (Personnel—Staff), New River Head, Rosebery Avenue, London EC1R 4TP.
Tel: 01-837 3300 Ext. 2024.

Thames Water

CHELSEA COLLEGE

**University of London
MASS SPECTROMETRY
UNIT ASSISTANT
OPERATOR—TECHNICIAN
GRADE 3**

Due to reorganisation and expansion of the College's Mass Spectrometry Unit we require an Assistant Operator to join the team responsible for providing an important service for both teaching and research purposes.

The post would be suitable for a person with a Physics/Chemistry qualified to at least HNC standard.

The successful candidate will have an interest in, and an aptitude for, physico-chemical instrumentation and will be given a sound training in the uses and applications of mass spectrometry in Chemistry and in the Biological Sciences.

This new post will enable a good academic background to be developed using the modern sophisticated instrumentation controlled by the unit.

Salary scale (under review)—£3153-£3525 inclusive of London Allowance.

Intending applicants are invited to visit the unit and appointments and application forms can be obtained from Mr G. T. Hughes, Superintendent of Laboratories, Chelsea College, Department of Chemistry, Manresa Road, London SW3 6LX. Telephone: 01-352 6421 ext. 150.

UNIVERSITY OF CAMBRIDGE

**Department of Physics
POSTDOCTORAL RESEARCH
ASSISTANT IN
THEORETICAL PHYSICS**

A vacancy exists for a Post-doctoral Research Assistant in the Theory of Condensed Matter Group of the Cavendish Laboratory. The area of interest is the theoretical study of semiconductor surfaces with particular emphasis on the properties of, and transport in, inversion layers. The successful candidate will work under the direction of Dr J. C. Inkson but will be expected to interact strongly with the very active experimental group in the Cavendish. The post is for an initial period of two years and is financed by the SRC. Applicants should have a PhD (or equivalent) and experience in the area of theoretical solid state physics (preferably semiconductors). The salary range will be £3883-£4882 per annum (under review).

Applications, including the names of two referees, should be sent before 16 April to: Dr J. C. Inkson, TCM, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE.

WELSH NATIONAL SCHOOL OF MEDICINE (University of Wales)

**DEPARTMENT OF
RESTORATIVE DENTISTRY**

RESEARCH OFFICER

required for work on a project concerned with the strength enhancement of Denture Base Polymers.

Applicants should preferably be Graduates in Materials Science or of equivalent status. Commencing salary could be up to £3883 per annum (depending on qualifications and experience).

Further particulars available from the Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff CF4 4XN (quoting ref. No. M16/D43/17) to whom applications, in the form of a curriculum vitae with the names and addresses of two referees should be submitted by 31 March, 1979.

Information Scientist

with responsibility for registration

Slough

c. £6,000

This important position with Johnson & Johnson, leading international manufacturers of health care and baby products, combines the key functions of maintaining an efficient scientific information service for our Department of Medical Affairs, and with responsibility for all aspects of the registration process for company products.

Your wide ranging duties will include monitoring relevant specialist publications, the use of computer techniques for information retrieval and circulating concise, accurate reports on all significant items of scientific and related interest within the company. On the registration side, you'll be expected to keep comprehensive files of international regulatory requirements, to obtain and submit all the necessary data for licence applications and similar, and to advise on all advertising and promotional literature. This challenging role will involve you in high-level liaison with senior company management and scientists

internationally, as well as with universities, medical schools, research organisations and UK and EEC regulatory authorities.

To apply, you should be a graduate in a life science with around three years' experience in a medical or scientific environment or a relevant further qualification. Ideally, you will combine a knowledge of information techniques with a background in registration, although well qualified candidates who meet one of these criteria will be considered. A reading knowledge of a second language will be a useful advantage.

Starting salary, negotiable around £6,000 will be backed by an impressive range of large-company benefits including bonus, BUPA and assistance with relocation if necessary.

Write with full career details to Anne Dunn, Johnson & Johnson Limited, 260 Bath Road, Slough, Berks SL1 4EA. Or ring Slough 31234 for an application form.

Johnson & Johnson

Public Service of South Australia DEPARTMENT OF AGRICULTURE AND FISHERIES PRINCIPAL OFFICER FISHERIES MANAGEMENT

The Fisheries Division is required to manage the fisheries resources of South Australia, with the overall objective of optimal economic efficiency while giving consideration to social factors.

A new position of Principal Officer, Fisheries Management has been created, responsible to the Assistant Director (Fisheries) to co-ordinate and manage the sections responsible for publicity (extension), licensing and enforcement. The task will require evaluating reports from licensing, enforcement and the information personnel on the effectiveness of existing policy, being involved in the development of new policy initiatives and effectively implementing approved management policies.

The Principal Officer, Fisheries Management will be expected to maintain liaison with industry and other groups, and to negotiate with such bodies as local authorities and development associations.

Salary Range:

\$20405/21046 per annum.

Qualifications:

An appropriate University degree is essential. A higher degree in biology, economics or related fields is desirable.

Experience:

Experience in applied research or policy development in natural resource management. Some experience and understanding of commercial activities and proven ability to communicate with people and groups of diverse interests.

Applications should include the names of three (3) referees from whom confidential enquiries may be made, should be marked "Confidential" and be addressed to:—The Personnel Officer, Department of Agriculture and Fisheries, Grenfell Centre, 25 Grenfell Street, Box 1671, G.P.O. Adelaide, South Australia 5001. Closing date for applications is April 20, 1979.

UNIVERSITY OF READING

Applications are invited for the following posts:

POSTDOCTORAL
FELLOWSHIP (SRC—2 YEAR
FIXED TERM)
CASE RESEARCH
STUDENTSHIP

Both vacancies involve research in the field of preparative and structural transition-metal chemistry.

Applications for the Fellowship must have relevant research experience: starting salary up to £4382 per annum (under review). USS superannuation.

Applications, accompanied by a curriculum vitae and the names of two referees, quoting reference MS 22A, should be sent to Professor G. W. A. Fowles, Department of Chemistry, The University, Whiteknights, Reading RG6 2AH.

UNIVERSITY OF LEICESTER Department of Physics RESEARCH ASSOCIATE IN CONDENSED MATTER PHYSICS

Applications are invited for a postdoctoral research associate to undertake a study of liquid semiconducting alloys using photoelectron spectroscopy. The project is part of a wider investigation of the properties of disordered systems being carried out in the Physics Department and supported by the Science Research Council.

The post is tenable initially until September, 1981 and the salary is from £3883 per annum. Applications with a curriculum vitae and the names of two referees should be sent to Dr C. Norris, Department of Physics, University of Leicester LE1 7RH.

Organic Chemists and Analysts

for chemical development with BRIDGE CHEMICALS

Continued expansion in our chemical development programme has created exciting openings for qualified Chemists at Bridge Chemicals, the UK manufacturing and chemical development facility of the Chemicals Division of the Smith Kline Corporation, a leading International Pharmaceutical Company.

Organic Chemists

£4500-£5500 p.a.

To investigate new synthetic routes, develop commercially viable processes for novel therapeutic agents and transfer these processes to production facilities worldwide.

Candidates should possess a flair for practical organic chemistry combined with an aptitude for innovative thinking. The positions would suit recently qualified PhD's or experienced graduates with

proven ability. For one position some pilot plant experience would be an advantage. Ref DB/2.

Analytical Chemist

£3800+ p.a.

To analyse pharmaceuticals, intermediates and novel synthetic materials, and develop new analytical procedures.

Applicants should be in their early to mid twenties, educated to degree level or equivalent with experience in analytical techniques. They should also possess the ability to apply their knowledge and experience to the solving of analytical and chemical problems. Ref BA9/1.

In addition to excellent starting salaries, we offer the successful men and women a discretionary annual bonus, free life assurance, an excellent contributory pension scheme and flexible working hours.

Please telephone or write quoting the appropriate reference number to Mrs P. D. Whitton, Personnel Administrator, Bridge Chemicals Limited,

SMITH KLINE CHEMICAL DIVISION

Old Powder Mills, Leigh, Hildenborough, Near Tonbridge, Kent TN11 9AN.
Tel: Tonbridge (0732) 833001.

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IMPERIAL CANCER RESEARCH FUND

COMPUTER PROGRAMMER

required to work with a team of scientists involved in cancer research. Initial responsibility will be the development of programs for the analysis of biomedical, clinical and experimental data. At least 2 years experience of Fortran programming is essential and the handling of large scale data files would be an advantage.

Salary range £3936 to £5256.

For further information and application form telephone or write to Miss S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2 on 01-242 0200 ext. 305.

NEWCASTLE AREA HEALTH AUTHORITY FREEMAN HOSPITAL DEPARTMENT OF MICROBIOLOGY

Applications are invited for the post of

Principal Scientific Officer

in the above Department.

The successful candidate will already be a person with considerable microbiological experience. He or she will be capable of independent research and development and have experience of organising and supervising scientific research with a strong clinical microbiological bias.

Freeman Hospital (813 beds) houses the regional units of Cardiothoracic medicine and surgery, Urological surgery and Nephrology. Excellent opportunities for research and the development of scientific services in co-operation with these and other specialities exist.

Salary Scale £6999 rising by 8 annual increments to £9177.

Application Forms available from Senior Personnel Assistant, Freeman Hospital, High Heaton, Newcastle upon Tyne NE7 7DN. Tel: 0632 843111 Ext. 3108.

UNIVERSITY OF ABERDEEN DEPARTMENT OF CHEMISTRY

Research Assistant

Applications are invited for the above post financed by the UK Atomic Energy Authority, under the supervision of Dr G. G. Cameron and concerned with methods of decomposing plastic and other polymeric items. The post is tenable until 31 December, 1980, from a date to be arranged as soon as possible. Applicants should hold a university degree or equivalent, preferably at honours level in chemistry.

Salary within Range 1B Scale for Research and Analogous Staff, £3384-£4382 per annum. Candidates interested in a part-time appointment will be considered.

DEPARTMENT OF BIO-MEDICAL PHYSICS & BIO-ENGINEERING

Research Assistant

Applications are invited for this post in a small group working on an evaluation of properties of short-term cultures of human tumour biopsy specimens with particular reference to their chemosensitivity. Applicants should have a degree in one of the biological sciences. Experience in either tissue culture or cancer research would be advantageous.

The appointment, funded by Cancer Research Campaign, is tenable until 31 October, 1979, to commence as soon as possible. Extension for a further year is likely, subject to satisfactory progress.

Salary £3883-£4382 per annum, on Range 1A Research and Analogous Staff Scale, with appropriate placing.

DEPARTMENT OF GEOLOGY AND MINERALOGY

Postdoctoral Research Fellowship

Applications are invited from suitably qualified organic geochemists or clay mineralogists to work with Dr M. J. Pearson on the correlation of organic matter and clay mineral diagenesis in sediments from the North Sea Basin. The project involves the study of kerogen maturation and hydro-carbon generation during burial in relation to clay mineral transformations as a response to temperature increase and ion concentration in interstitial water. The post is tenable for three years and is supported by the Natural Environment Research Council.

Salary £4382-£4882 per annum on Research and Analogous Staff Range 1A Scale, with appropriate placing.

Further particulars for all of the above posts from The Secretary, The University Aberdeen, Tel. 0224 40241 with whom applications (2 copies) should be lodged by 30 March, 1979.

UNIVERSITY OF SOUTHAMPTON Institute of Sound and Vibration Research Vibrational Power Flow RESEARCH FELLOWSHIP

A Research Fellow is required to develop experimental techniques and instrumentation for the measurement of power flow through structures.

Applicants should preferably have some previous experience in structural dynamics and must possess a good honours degree in Engineering or an equivalent qualification. Suitable applicants will be encouraged to register for a higher degree.

Salary up to £5129 (under review) plus USS benefits.

Applications should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, giving a brief curriculum vitae, the names of two referees and quoting reference 190/R/NSC.

Gas

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of R&D careers

SENIOR ENGINEERS

Structural Analysis
Newcastle-upon-Tyne
up to £6774

The Engineering Research Station at Killingworth provides a development and consultancy service on all engineering problems throughout the wide ranging activities of British Gas.

The continuing increase in supply of natural gas, with the associated expansion of supply and storage networks and increased complexity of plant and equipment, has created the need for additional engineers to join a small specialised team in the Structural analysis Section. This Section provides a stress analysis service to projects within the Research Station and consultancy to the Gas Industry. The work involves some development of classical and computer based methods but is concerned primarily with the solution of structural analysis problems using established finite element techniques.

Applicants must have a good engineering degree and a thorough understanding of basic structural analysis theory. Experience in the design and application of computer techniques to structural analysis would be an advantage.

Salaries will be, depending upon age and experience, in the range £4833-£5712 or £5253-£6774.

Please phone or write for an application form, quoting ref: ERS/908/NS to the Personnel Assistant, Engineering Research Station, Killingworth, Newcastle-upon-Tyne. Tel: (0632) 684828.

APPLIED MATHEMATICIAN/ PHYSICIST

Non-Destructive Testing
Newcastle-upon-Tyne
up to £5712

The British Gas On Line Inspection Centre has achieved an international reputation for its development of improved methods of inspecting high pressure pipelines. This has involved making use of advanced technology in the fields of electronics, computing and mechanical engineering.

The Centre is to be located at Cramlington, Northumberland, but is currently at Killingworth, Newcastle-upon-Tyne.

A group of physicists are engaged on research into the principles of non-destructive testing on which such devices are based. The job is biased towards theoretical study particularly of magnetic and electromagnetic fields in conjunction with experimental programmes and will involve becoming familiar with

numerical computational methods, e.g. finite element and finite difference techniques.

Applicants should have at least a good degree, preferably in applied maths or physics or, perhaps, electrical engineering. The project applies the latest technology in electronics, computing and mechanical design to meet its stringent testing requirements. This post will involve working with people in all these disciplines.

Salary within the range £4833-£5712.

Please write, quoting reference OLI/314/NS with full details of age, qualifications, experience and current salary to Margaret Harrison, Personnel Assistant, British Gas, Research and Development Division, On Line Inspection, PO Box 1LH, Killingworth, Newcastle-upon-Tyne. Tel: (0632) 684828 ext. 380.

ECONOMIST

Cost benefit analysis
in Engineering
Newcastle-upon-Tyne
up to £5712

The Engineering Research Station in Killingworth is the centre within British Gas for the study of a wide range of engineering problems, and is recognised internationally in the transmission and distribution of natural gas.

A numerate economist, or a scientist/engineer with economics as a special option, is required to undertake cost benefit analysis in support of major R&D projects. These range from the Industry's plant replacement programme to studies of the interaction between manpower and increasingly sophisticated equipment.

The ideal candidate will have several years post-qualification experience, preferably gained in an industrial environment. Good analytical ability is essential and computer programming on FORTRAN would be an advantage.

The Engineering Research Station is a pleasant modern building, situated close to outstanding countryside. Ref: ERS/909/NS. Salary within the range £4833-£5712. For application details see vacancy below.

PHYSICIST

Fluid Flow
Newcastle-upon-Tyne
up to £5712

Based in the Dynamics Division of the Engineering Research Station, at Killingworth. You will join a Physics of Fluids research group studying problems resulting from non-steady fluid flow in natural gas process and storage plant and related piping systems.

The duties involve theoretical and experimental work leading to the solution of fluid and aero-dynamic problems and collaboration with acoustics, thermodynamics and structural dynamic teams.

A good degree in physics or engineering plus at least one year's experience on one of the above fields is essential. Ref: ERS/178/NS.

Salary within the range £4833-£5712.

Please write for an application form quoting reference ERS/178/NS, to the Personnel Assistant, Engineering Research Station, PO Box 1LH, Killingworth, Newcastle-upon-Tyne NE99 1LH.

All posts are open to men and women.

In addition to salaries quoted, there is currently a self-financing productivity payment, plus the benefits normally associated with a large progressive organisation.

Assistance with relocation expenses available where appropriate.

ANALYTICAL CHEMISTS

Substitute Natural Gas
West Midlands
up to £5712

The Midlands Research Station of British Gas has earned a world-wide reputation in the international exploitation of its development of processes for the production of substitute natural gas.

The Station is situated at Solihull close to the Warwickshire countryside and offers excellent support services including extensive engineering, analytical and computer facilities.

A number of chemists interested in the analytical field, are required to support teams working on the development of high pressure processes for the production of substitute natural gas by known and novel process routes from oil feedstocks and coal.

The position would appeal to those who are graduating this year, or who have 1-2 years experience since graduation, preferably (but not necessarily) in the analytical field. A knowledge of one or more of the techniques of gas chromatography, high pressure liquid chromatography, metallurgical procedures or X-ray fluorescence spectroscopy and experience in the use of these in direct, or automated ("on-line") situations would be an advantage.

It is preferable that applicants should have or expect to obtain at least a 2nd class honours degree or an equivalent professional qualification.

Commencing salary will be dependent upon qualifications and experience but will be on a scale which rises to £4332 with prospects of promotion to scales rising to £4746-£5712.

Please write for an application form quoting reference numbers MRS/241/NS to the: Research Secretary, Research and Development Division, British Gas, Midlands Research Station, Wharf Lane, Solihull, West Midlands B91 2JW.

TECHNICAL OFFICERS

London up to £5248

Two Technical Officers are wanted to work in a group carrying out research into methods of gasifying oil and coal. The work will consist of measurements on surface properties of catalysts and coal used in the research and of running a laboratory scale oil hydrogenator. Normal qualifications will be an HNC in chemistry or chemical engineering but candidates with 'A' levels or ONC in scientific subjects plus a few years laboratory experience will be considered.

Candidates should be between 21 and 25 and the salary will be in the range £3262-£5248 (Including Inner London Weighting).

Further details and an application form can be obtained from Research Secretary, British Gas, London Research Station, Michael Road, Fulham, London SW6, quoting reference LRS/211/NS.

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London WC2
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UNIVERSITY OF NEWCASTLE UPON TYNE

The Department of Naval
Architecture and Shipping
LECTURER

Applications are invited from men and women for a lectureship in the Department of Naval Architecture and Shipbuilding. The work of the Department, which is part of the School of Marine Technology, embraces the design, construction and operation of ships and other marine vehicles or systems. Preference may be given to applicants with qualifications and experience in Marine Transport and Operations or in Design and Optimisation; but those with other interests are encouraged to apply. Teaching may be at undergraduate, post-graduate, or post-experience levels. Opportunities for research and involvement with industry are good.

Salary will be at an appropriate point on the Lecturers' scale: £3883-£7754 per annum, according to age, qualifications and experience. Membership of the appropriate University superannuation scheme will be required.

Further particulars may be obtained from the Senior Assistant Registrar, The University, 6 Kensington Terrace, Newcastle upon Tyne NE1 7RU, with whom applications (three copies), together with the names and addresses of three referees, should be lodged not later than 6 April, 1979. Please quote reference NS.

UNIVERSITY OF YORK

Department of Biology

Applications are invited for a post of

TECHNICIAN GRADE 5

to assist in a Research Project on Coal Waste Materials. Experience in methods of soil and plant analysis will be necessary. The post is for approximately two years in the first instance and salary is on scale £3186-£3720 (under review). Candidates should possess City & Guilds, HNC or a degree and have relevant experience.

Applications in writing to the Laboratory Superintendent, Department of Biology, University of York, Heslington, York YO1 5DD, with the names and addresses of two referees, by Friday 23 March, 1979.

UNIVERSITY OF DURHAM

Department of Chemistry

Applications are invited for the post of

SENIOR DEMONSTRATOR

in the Department of Chemistry from 1 October, 1979. The main duties will be to help with the practical teaching of Organic Chemistry, with tutorials for second and third year students, and to carry out research. An interest in some branch of organofluorine chemistry or polymer chemistry (preparative or structure and bonding by means of photoelectron spectroscopy) and a willingness to join existing groups working in these fields would be an advantage. There will be opportunities for the person appointed to give some lectures.

The appointment will be for three years. Initial salary in the range £3584-£4631 per annum (under review) on Scale IB or IA, depending on qualifications, with membership of USS.

Applications (three copies) naming three referees should be sent by 18 April, 1979 to the Registrar and Secretary, Science Laboratories, South Road, Durham DH1 3LE, from whom further particulars may be obtained.

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Pathology and
Medical Statistics
JUNIOR RESEARCH
ASSOCIATE

Applications are invited from honours graduates, or prospective honours graduates, in biological sciences for a post as Junior Research Associate to assist in a research project investigating cell proliferation in the gastrointestinal tract. The work, which is sponsored by the Cancer Research Campaign, will involve cell kinetic and other experiments on hyperplastic and neoplastic gut in rodents. The post is available for three years starting on 1 August, 1979 or as soon thereafter as can be arranged. Commencing salary £3384 per annum on the National Range 1B scale. The successful candidate will be expected to enrol for a higher degree.

Further particulars may be obtained from Dr A. J. Watson, Department of Pathology, University of Newcastle upon Tyne NE1 7RU, (0632 25131 Ext 445) to whom applications giving full curriculum vitae and the names of two referees should be sent by 30 April, 1979.

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Zoology

The University invites applications for the post of

DEMONSTRATOR

in the Department of Zoology. Preference will be given to candidates with experience in comparative physiology or experimental zoology. Applicants should possess a higher degree or have equivalent postgraduate research experience. The appointment will be for a period of three years tenable from 1 September, 1979.

Salary will be at an appropriate point on the Grade IB(bar) scale £3384-£4882 per annum according to age, qualifications and experience. Membership of the appropriate University superannuation scheme will be required.

Further particulars may be obtained from the Senior Assistant Registrar, The University, 6 Kensington Terrace, Newcastle upon Tyne NE1 7RU with whom applications (three copies), together with the names and addresses of three referees, should be lodged not later than 9 April, 1979. Please quote reference N.

UNIVERSITY OF BATH

School of Engineering

RESEARCH OFFICER (DIESEL COMBUSTION)

A graduate engineer/technologist is required to assist with experimental and analytical work in connection with a new SRC sponsored research project concerned with Diesel type combustion.

The research officer will work with a small team under the direction of Professor F. J. Wallace and Dr R. J. B. Way and would be responsible for the design, instrumentation and operation of a new combustion rig. Some knowledge of classical reaction kinetics and experience of classical analysis methods would be an advantage.

Candidates should have a good honours degree in mechanical or chemical engineering, or chemistry.

The appointment is for a period of three years.

Salary up to £4882 per annum (under review) according to qualifications and experience.

Application forms from the Personnel Officer, University of Bath, Bath BA2 7AY, quoting reference number 79/60NS. Closing date will be 2 April, 1979.

LONDON BOROUGH OF HARINGEY

Education Service

FULL-TIME SENIOR LABORATORY TECHNICIAN

Alexandra Park School,
Rhodes Avenue N22

Salary/Grade: NJC Technical Grade 4-£4530 per annum rising to £4917 per annum inclusive.

Alexandra Park School is housed in two buildings, one mile apart, each in pleasant surroundings. There are eight laboratories and a team of technicians which now requires a Senior Technician to lead it.

The assistant to the Senior Technician is based in the lower school.

A person of energy, foresight and enthusiasm is sought to fill this very important post in the Science Department. The Department is very active and forward looking and runs courses for CSE, "O" and "A" levels. There is a greenhouse and a beehive and space for allotments.

Qualifications: Higher National Certificate or Higher National Diploma, City & Guilds Laboratory Technicians Advanced Certificate, United Kingdom degree of Dip Tech, Associateship of Institute of Science Technology or an equivalent suitable qualification or 10 years suitable experience.

FULL-TIME LABORATORY TECHNICIAN

The Somerset School,
White Hart Lane N17

Salary/Grade: NJC Technical Grade 2-£3564 per annum rising to £3936 per annum inclusive.

This is a boys' comprehensive school and the main routine responsibilities would be in the physics laboratories.

Special Qualifications: Ordinary National Certificate or Ordinary National Diploma, City & Guilds Laboratory Technicians Certificate, four GCE passes with two at "A" level in appropriate subjects, Membership of Institute of Science Technology or an equivalent suitable qualification or five years suitable experience.

For the above two posts: details obtainable from Chief Education Officer, Education Offices, Somerset Road N17. Applications returnable by: 30 March, 1979.

All posts are open to male and female applicants.

UNIVERSITY OF STRATHCLYDE

Applications are invited for the following research posts in the DEPARTMENT OF PURE AND APPLIED CHEMISTRY, available in October 1979 in biologically oriented ORGANIC CHEMISTRY.

1. A POSTDOCTORAL RESEARCH FELLOWSHIP

financed by SRC for a period of two years to research on the Scope and Mechanism of Selective Hydroxylation by Alkyl-substituted Chelates of Iron.

2. A POSTDOCTORAL RESEARCH ASSISTANT

financed by MRC for a period of three years to research on the Synthesis and Evaluation of Potential GABA-mimetic Substances.

Appointments on Range 1A of the national salary structure for research and analogous staff, with a commencing salary on the scale £3883-£4382 per annum with placing according to qualifications and experience. Superannuation benefit. Appointments will commence from 1 October, 1979, or as soon as possible thereafter.

Written applications (quoting R9/79) with names and addresses of two referees should be submitted to Dr C. J. Suckling, Department of Pure and Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow G1 1XL, from whom further information can be obtained.

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So what we're offering at Digital is a chance for you to use your experience in a different, exciting and very rewarding new direction. It's a unique opportunity—one that might never come again. We'll give you all the training you need to make the most of your abilities and experience with a professional informal and fast expanding company.

Our need is for men and women, qualified to degree/HNC level or equivalent, who have proven, wide-ranging engineering experience. In addition, you should have the personal qualities of confidence, maturity, enthusiasm and ambition.

We won't pretend it's an easy job because selling computers is really about solving complex problems. You'll need to be able to communicate well, to be resourceful, well motivated and imaginative. What we do promise is that you'll work hard and be well rewarded both financially and in terms of job satisfaction and promotion prospects.

So if you know about mini-computers, make the most of it. Find out more about selling with Digital by writing to Ken Lanham, Personnel Department, Digital Equipment Co. Ltd., 252-256 Kings Road, Reading, Berks. Telephone: Reading (0734) 599049. Please quote ref: 522.

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Radiochemist

Smith Kline and French Laboratories Limited is the UK subsidiary of the International Smith Kline Corporation whose interests include the research and manufacture of pharmaceuticals. The Company's Research Institute presently operates in Welwyn Garden City but over the next few years will be moving a few miles to newly built laboratories in a rural setting. The Research Institute is seeking a chemist to join the Radiochemical Department and work on the synthesis of isotopically-labelled compounds.

Applicants male or female should have HNC, BSc, or equivalent qualifications and they must be experienced in practical organic chemical techniques, preferably on a small scale. Previous experience of working with radio-labelled

compounds and a knowledge of separation and purification methods, particularly HPLC, would be an advantage although appropriate training will be given.

This is an opportunity for a young chemist who wishes to make a career in the pharmaceutical industry to join a successful and expanding section. There will be scope for initiative and the opportunity of working with the minimum of supervision.

We offer competitive salaries on progressive incremental scales. For example, the starting salary for a suitably qualified graduate will be in excess of £4000 per annum. Other benefits include a discretionary annual bonus, free life assurance, a contributory pension scheme, and, for this post, flexible working hours.

Please write or telephone for an application form quoting

Ref. No. NSC 157, to:—

Kate Viscardi, Recruitment Administration Officer,

SMITH KLINE & FRENCH LABORATORIES LIMITED

Mundells, Welwyn Garden City, Hertfordshire AL7 1EY.

Telephone: Welwyn Garden 25111 ext. 26.



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Laboratory Opportunity in Drug Research

Safety Evaluation of New Drugs: Herts.

We need someone to join a team conducting toxicological studies on newly discovered drugs in our Pathology Department. The successful candidate will assume a responsible position and must be capable of supervising some of the studies within a short time of appointment.

Applicants must have an HNC/HND in Biology or a degree in a Life Science. They must be clear thinking individuals with initiative, the ability to exercise judgement, and an interest in working with animals.

This position carries a competitive salary which will be related to the age, experience and qualifications of the successful candidate. Other benefits include subsidised meals, pension, profit sharing and productivity schemes, and extensive sports & social facilities.

Please apply to:

Mrs M. G. Haufe, Personnel Officer,
Glaxo-Allenburys Research (Ware) Ltd,
Ware, Herts. SG12 0DJ.
Tel: Ware 3232.

Glaxo-Allenburys Research (Ware) Limited

DEPARTMENT OF BIOCHEMISTRY

TWO POSTDOCTORAL RESEARCH ASSISTANTSHIPS

Applications are invited for two S.R.C. supported Postdoctoral Research Assistantships (Grade 1A) to participate in research programmes concerned with NMR studies in biological systems.

1. **One person appointed** will join a group under the direction of Dr I. D. Campbell and Sir Rex Richards and will be involved in developing the application of a 470 MHz NMR instrument to a variety of biochemical problems of interest to the Oxford Enzyme Group. This position is for two years and preference will be given to a candidate with a background in physics or physical chemistry with some interest in NMR techniques.

2. **The second appointment** is for three years. The person appointed will join the group under the direction of Drs G. K. Radda and D. G. Gadian concerned with studies of perfused organs (heart, kidney and muscle) by NMR and biochemical techniques. Persons with a background in physiology, biochemistry or chemistry will all be considered.

Both positions are available from 1 October 1979 and are on a salary scale of £3883 to £4882 per annum, dependent on age and qualifications, with U.S.S. superannuation benefits.

Applications should be sent to the Administrator, Department of Biochemistry, South Parks Road, Oxford OX1 3QU before 31 March 1979 from whom further particulars may be obtained.

JOHN INNES INSTITUTE NORWICH

HEAD OF VIRUS RESEARCH DEPARTMENT

Applications are invited for the above position.

The Department is concerned with the biochemistry and biophysics of plant viruses, mycoplasmas and their constituents, the structure and composition of proteins, the composition and function of nucleic acids, and related topics. Work in similar fields is carried out in the other three departments and collaboration between departments is encouraged.

The facilities available in the Institute are comprehensive. Teaching at undergraduate and post graduate level may be undertaken. The Institute is modern and well situated. Further particulars may be obtained from The Director, Professor Roy Markham, FRS.

The post is graded as Senior Principal Scientific Officer (£10 043-£11 300). Non-contributory superannuation.

Applicants should forward curriculum vitae, list of publications and names of suitable referees to The Secretary, John Innes Institute, Colney Lane, Norwich NR4 7UH, by 31 March, 1979.

UNIVERSITY OF LONDON GOLDSMITHS' COLLEGE

New Cross, London SE14 6NW

Technician

Required in the Psychology Laboratory to start as soon as possible. Applicants should have qualifications and/or experience in one of the following:—

- (a) Maintenance of electronic equipment (eg CC TV and general audio-visual equipment).
- (b) Construction and maintenance of general laboratory equipment involving general workshop procedures.

The appointment will be on either Grade 3 or 5 depending upon qualifications and experience, with salary on one of the following scales:—

Grade 3—£2697 x 5 increments to £3084 per annum

Grade 4—£2976 x 5 increments to £3426 per annum

Grade 5—£3210 x 5 increments to £3747 per annum plus £465 London Allowance

Write for further particulars, to the Personnel Officer, to whom applications should be sent by 30th April, 1979.

Electronic Engineers and Physicists Outstanding Research Opportunities

EMI's Central Research Laboratories at Hayes, Middx., have many firsts to their name. Here was developed the first airborne reconnaissance radar, the first high definition television, the first stereo recording system and, more recently, the first CT Scanner.

In order to achieve more firsts we currently need Electronic Engineers and Physicists with a good degree and an innovative approach to advanced research.

The successful applicants will be involved in interesting projects in one or more of the following areas:-

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Ultrasonic underwater imaging
High voltage electrical systems and their associated electronics

Salary and career development properly reflect the Company's very high regard for creative scientific brainpower and experience. Equally generous fringe benefits are provided including relocation expenses where appropriate.

If you can demonstrate a record of success in your career to date and wish to be considered for one of these vacancies write in confidence to: Neil Robotham, Personnel Department, EMI Limited, 135 Blyth Road, Hayes, Middx or telephone him on 01-573 3888 ext. 3016 or Record-a-Call anytime on 01-573 5524.

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For further details please contact Jeanette Eames on 01-831 6471 or 01-242 4266 (direct)

UNIVERSITY OF DUNDEE DEPARTMENT OF MATHEMATICS

There is a vacancy for a

LECTURER IN MATHEMATICS (COMPUTATIONAL SCIENCE)

in the above Department and applications for it are invited from suitably qualified candidates.

Salary scale £3883 to £7754 (under review) with initial placing dependent on qualifications and experience. Superannuation under USS, or continuation of FSSU.

Applications in writing (six copies, overseas applicants one copy) containing full curriculum vitae and the names of two referees should be sent by 5 April, 1979, to The Secretary, The University, Dundee DD1 4HN from whom further particulars are available. Please quote Reference EST/36/79H.

CANCER RESEARCH CAMPAIGN 4 MV VAN DE GRAAFF

ELECTRONICS OR ELECTRICAL JUNIOR TECHNICIAN/TECHNICIAN

required to assist with the operation, maintenance and development of the 4MV VAN DE GRAAFF accelerator recently installed at the Gray Laboratory. This unique multi-purpose machine is used for research aimed at improving the radiation treatment of cancer. Support facilities include electronics and mechanics workshop and a PDP11 computer.

Candidates, preferably with HNC or degree and some relevant experience. Starting salary to £5034 pa (review due 1st April, 1979) according to experience, qualifications and age.

Further information and application form, in confidence, from:

Deputy Director
CRC Gray Laboratory
Mount Vernon Hospital
Northwood, Middx. HA6 2RN.

(Telephone: Northwood 28611)

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Royal Engineering College
Manadon, Plymouth

Senior Computer Programmer

The College is primarily concerned with the education and training of naval Engineering Officers to achieve those standards required for chartered engineer status. It has extensive, well-equipped Laboratories and computer facilities to support the activities.

The programmer appointed will be responsible for developing programming techniques and applications programming in the College, particularly computer graphics, and will advise staff and students in this area. In addition, the successful candidate will take responsibility for, inter alia, the design and implementation of a Computer Assisted Learning Package, the support of the GINO-F software of the Xerox Sigma 6 Main-frame Computer and advising on the selection, purchase and acceptance of equipment.

Candidates, normally aged under 30 should have a good honours degree or equivalent in an appropriate discipline and some programming experience.

Appointment as Higher Scientific Officer (£4100-£5450) or Scientific Officer (£2840-£4410) according to qualifications and experience.

For further details and an application form (to be returned by 5 April 1979) write to Scientific Personnel Officer, Admiralty Underwater Weapons Establishment, Portland, Dorset DT5 2JS. Please quote ref: SA/11/FFA.

Ministry of Agriculture, Fisheries
and Food, Fisheries Laboratory,
Burnham on Crouch

Protection of the Marine Environment

This post is in the Aquatic Protection Division of the Laboratory, where the scientist appointed will be responsible for advising on the effect of effluent discharges on the marine environment, particularly tidal and estuarial waters. This work will require the use of a variety of data sources related to land based discharges and petroleum hydrocarbons and calls for an ability to assess the significance and extent of pollutants in the marine and other aquatic environments.

Candidates, normally aged under 32, should have a good honours degree, or equivalent, in mathematics, physics, engineering, chemistry or closely related discipline, coupled with at least 4 years relevant experience. A knowledge of effluent control is highly desirable.

Appointment as Senior Scientific Officer (£5150-£6900) with starting salary according to qualifications and experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 6 April 1979) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours).

Please quote ref: SB/44/AD.

Occupational Hygiene

in newly formed units at Devonport,
Portsmouth, Rosyth and Chatham

The Occupational Health Organisation of the MOD (Navy) provides a comprehensive medical, nursing and hygiene service to HM naval bases and regional shore establishments in the UK. These posts, in the regional hygiene units, offer experienced and newly qualified hygienists the opportunity to develop and apply their specialist knowledge in an important and expanding field. Each Unit will be staffed by two officers working on the identification, measurement and evaluation of a variety of chemical and physical hazards and advising on suitable methods of control. This will involve close liaison with the safety organisation, MOD Laboratories, the Institute of Naval Medicine and regional establishments.

Candidates, normally aged under 32, should have

a good honours degree or equivalent in an appropriate discipline. The Diploma of Occupational Hygiene, Membership of the Institute of Occupational Hygienists or equivalent is essential for some posts, which are at senior scientific officer level.

Appointment as Senior Scientific Officer (£5150-£6900), Higher Scientific Officer (£4100-£5450) or Scientific Officer (£2840-£4410) according to qualifications and experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 6 April 1979) write to Ministry of Defence, CM(S)1b3, Room 310, Savoy Hill House, Strand, London WC2R 0BX. Please quote ref: SA/2/E.

Ministry of Defence

ALL THESE POSTS ARE OPEN TO MEN AND WOMEN.

**Science
Group**
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Top jobs for ONC/HNC/HND/AIMLT BSc. (Chem; Phys; Biol; Med. Lab. subjects; Electronics and Metallurgy.)

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HIGHGATE SCHOOL PHYSICIST

Required in April 1979 for One Term a graduate Physicist to teach throughout the School. Highgate School Salary Scale; married or bachelor accommodation probably available. Write as soon as possible to Head Master, Highgate School, London N6 4AY (Tel: 01-340 1524).

IN A RUT?

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ATA SELECTION

LABORATORY ASSISTANT/ TECHNICIAN

required for Biology Laboratories, in April. Salary on Surrey LEA scale according to qualifications and experience. Interest in natural history or museum techniques an advantage. Further particulars from and applications to The Bursar, Epsom College, College Road, Epsom, Surrey—telephone Epsom 23273.

Chemist/ Preformulation Studies

A Chemist is required in our preformulation studies group to undertake preformulation and compatability studies.

A scientific approach to the study of the physical and chemical properties as they relate to the drug entity and dosage forms will be expected.

The successful candidate will have experience of a range of analytical and physical techniques and of their application in preformulation work.

Some computer experience would be an added advantage.

This position required a graduate in Chemistry with a good Honours Degree or higher, preferably with experience in the chemical and physical aspects of pharmacy.

The successful applicant will work within a multi-disciplinary team in our modern, well equipped INTERNATIONAL DEVELOPMENT LABORATORIES situated in pleasant location on the Wirral Peninsula.

The Company offers an excellent range of employee benefits including a competitive salary, non-contributory pension and life assurance scheme and flexible working hours (35 hour week).

Applications in writing please, giving full details of qualifications and experience to D.J. Palmer, Manpower Planning & Development Manager, E.R. Squibb & Sons Ltd., Reeds Lane, Moreton, Wirral, Merseyside, L46 1QW.



SQUIBB

Investigator Nickel Extraction

The Company, part of a world wide group, operates a modern Nickel Refinery and associated Chemical Products Plant at Clydach, near Swansea, South Wales.

We are seeking an Investigator to join the extraction section of our Process Research Department. The successful applicant will undertake research into roasting and the nickel carbonyl extraction process.

Applicants should possess a good honours degree in Chemistry, Metallurgy or Materials Science and at least three years relevant post graduate experience.

Salary and terms of service are fully competitive and include a non-contributory Pension and Life Cover Plan. Reasonable relocation expenses will be paid where necessary.

Please write for an application form to the:
Senior Personnel Officer, INCO EUROPE LIMITED,
Clydach Refinery, Clydach, Swansea, SA6 5QR

INCO

INCO EUROPE LIMITED



Beecham

Beecham Products would like to hear from appropriately and well qualified graduate scientists able to provide practical research leadership for the further development of the Beecham UHU range of adhesives and associated consumer products. Previous experience in adhesives technology and product development would be an important advantage. To be successful a candidate would need to demonstrate a capacity to liaise with marketing and production colleagues working to agreed product objectives and timetables.

Adhesives research in the U.K. is based in one of the Research Department laboratory sites, currently at Leatherhead, and will be conducted in close association with another Beecham Research Laboratory at Buhl, West Germany.

More than one appointment may be possible if candidates with appropriate seniority and experience are available. If interested, please send details of your education, qualifications, career and career expectations to:

David Short, Personnel Manager,
Beecham Products, Beecham House,
Brentford, Middlesex TW8 9BD.

Please indicate dates available for interview at short notice in Brentford or Leatherhead.

Thames and Hudson whose last two publications in the field of **Popular Science**

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whose prime responsibility will be developing this part of the list. Basic requirements are:

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Thomas Neurath, Managing Director
Thames and Hudson Ltd
30 Bloomsbury Street, London WC1B 3QP



Scientists for Engineering Research Projects

These posts are an opportunity for numerate scientists to join a unit providing mathematical and statistical support to the research projects of the Royal Electrical and Mechanical Engineers at Andover.

SENIOR SCIENTIFIC OFFICER

The senior scientist appointed will take responsibility for the construction and validation of mathematical models for logistic support systems, using analytical techniques with digital simulation and presentation of scientific and mathematical operational analysis studies. Additional duties will include supervising statistical studies involving FORWARD and MIAS data, advising on the development of equipment reliability study programmes for ADP and training army personnel in operational analysis and statistical methods in management science.

Candidates, normally aged under 32, must have a good honours degree or equivalent in mathematics, statistics, operational research, or closely related discipline and at least 4 years' relevant post-graduate experience.

Appointment as Senior Scientific Officer (£5150-£6900) with starting salary according to qualifications and experience. Promotion prospects.

Non-contributory pension scheme.
Ref: SA/1/EX.

SCIENTIFIC OFFICER

The scientist appointed to the second post will be responsible for the analysis of data obtained from military information systems on the establishment of standards and trends for equipment reliability and repair sources management. In addition, the successful candidate will provide a statistical service to REME.

Candidates, normally aged under 27, must have a Degree in a relevant scientific discipline. A working knowledge of statistics is advantageous.

Appointment as Scientific Officer (£2840-£4410) with starting salary according to qualifications and experience. Promotion prospects. Non-contributory pension scheme.
Ref: SA/2/EX.

Science Group
CIVIL SERVICE

For further details and an application form (to be returned by 2 April, 1979) write to Ministry of Defence, CM(S)1b3, Room 310, Savoy Hill House, Strand, London WC2R 0BX. Please quote appropriate reference.

BLOOD PRODUCTS LABORATORY

BIOCHEMIST FOR IMMUNOLOGICAL PRODUCTS

A graduate biochemist is required to take charge of a small group, with the Fractionation Section, engaged in the routine preparation for clinical use of protein fractions, mainly immunoglobulins and related proteins, from human blood plasma. The work of the group includes fractionation of plasma, antibody assays, the preparation and filling of sterile fluids. The products are intended for clinical use.

The person appointed will, after initial experience, become responsible to the Section Head for the work of the group, including the supervision of staff. It will be an advantage to have previous experience of separation and purification of immunological products or related experience.

Please apply to Mr G. M. Bailey, the Blood Products Laboratory, Dagger Lane, Elstree, Herts WD6 3BX, forwarding a c.v. or telephone 01-953 6191 for an application form quoting reference BPL 13. Closing date 31 March 1979.

MEDICAL RESEARCH COUNCIL

RESEARCH ASSISTANT

(Technician/Research Officer—
Salary scale £3261-£4902)

The MRC Clinical Psychiatry Unit requires a Psychologist or Social Science Graduate for three years to join a small team working on clinical and psycho-physiological studies which include suicide, depression, schizophrenia and expressive movements in psychiatric disorders. The job entails psychological testing and previous clinical experience is necessary. There will be opportunities for training in research methods, and the person appointed will be encouraged to accept individual responsibility for specific aspects of the research projects. Starting salary will depend on previous research experience. The post becomes vacant on 1 June, 1979.

Applications to the Director, MRC Clinical Psychiatry Unit, Graylingwell Hospital, Chichester, Sussex PO19 4PQ, enclosing curriculum vitae and the names of two referees. Closing date for applications: 20 April.

THE ROYAL MARSDEN HOSPITAL DOWNS ROAD SUTTON SURREY

Technician

Nuclear Medicine Dept.
Salary: £2700-£3621/£3285-£4188

Technician required to complete a team of three in an in vitro laboratory carrying out mainly routine test involving radioisotopes. The work is rewarding and requires an interest in patient contact.

Applicants should have 2 'A' Levels including a science subject and 3 years technical experience or ONC/HND.

Application forms from: Personnel Dept., Royal Marsden Hospital, Fulham Road, London SW3. Phone 352-8171 Ext 446. Closing date: 29 March, 1979.

UNIVERSITY OF BRISTOL Department of Zoology

RESEARCH TECHNICIAN Grade 3

is required for one year from 1 April, 1979, to work on the biological assessment of rivers using chironomids. Commencing salary £2688 per annum (scale under review).

Applications, in writing, quoting the names of two referees, should be sent to Dr R. S. Wilson, Department of Zoology, University of Bristol, Bristol BS8 1UG.

LEICESTER POLYTECHNIC

School of Chemistry

Applications are invited for

THREE RESEARCH ASSISTANTSHIPS

to study for CNAAP PhD degrees in a small well-motivated and friendly department in which twenty research students are investigating problems in six main areas. The present posts are in:

- 1. POLYMER AND ADHESION SCIENCE.** The object is to elucidate the mechanisms by which water affects the durability of epoxide-metal adhesive joints. The programme, which is directed towards aero-space applications, will be supervised by Dr John Comyn and Dr Derek Brewis.
- 2. ELECTROCHEMICAL OXIDATIONS OF ORGANIC COMPOUNDS.** It is hoped to replace such oxidising agents as permanganate and dichromate, which cause severe effluent problems in the pharmaceutical and other industries, by electrochemically grown metal oxide films and porous electrodes. The programme is supervised by Dr Roger Latham and Dr Ralf Dahm.
- 3. SOLID STATE BATTERIES.** The aim is to study fundamental aspects, especially of the interfaces within the cell, of certain silver copper and other novel battery systems. The work is associated with a commercially sponsored project, both being supervised by Dr Roger Linford.

Salary: £2673 pa plus annual increments. Posts renewable for a max. of three years. Application forms and further details from the Staffing Officer, Leicester Polytechnic, P.O. Box 143, Leicester LE1 9BH; informal enquiries to Roger Linford, Reader in Chemistry (0533-50181, extn. 2202).

LABORATORY SCIENTIFIC OFFICER

with HNC or equivalent qualification (or Junior Laboratory Scientific Officer of high quality) required as soon as possible for one year to complete an MRC supported study on cytomegalovirus infections in Department of Microbiology. Experience in virology or cell culture essential.

Salary for qualified Laboratory Scientific Officer not less than £3261 plus £354 London Weighting.

Applications with full details and names of two referees to the Secretary, Guy's Hospital Medical School, London Bridge SE1 9RT, quoting reference MC.

BASINGSTOKE AND NORTH HAMPSHIRE HEALTH DISTRICT SENIOR ELECTRONICS TECHNICIAN

to install and maintain electronic medical equipment in Basingstoke and Alton. Qualifications: ONC, HNC or equivalent. Salary: £3744-£4788 per annum.

Application forms and job descriptions available from the District Personnel Department, Basingstoke District Hospital, Aldermaston Road, Basingstoke, Hants. Tel: Basingstoke 29908/9. Quote reference number NS11/09498. Closing date: 9 April, 1979.

COMMONWEALTH AGRICULTURAL BUREAU

Vacancy for SCIENTIFIC INFORMATION OFFICER

at the
COMMONWEALTH FORESTRY BUREAU

Commonwealth Forestry Institute
South Parks Road, Oxford OX5 3RD

Duties of post: The scrutiny of technical literature, selection and preparation of abstracts in many subjects related to forestry or forest products (this may involve visits to outside libraries), indexing, preparing for the press and dealing with technical enquiries.

Flexible working hours are based (on 37 hours per week. Applicants wishing to work 18½ hours per week, with appropriate adjustments of salary, etc, will be considered.

Qualifications: Applicants should be graduates in forestry or in a biological science or in a relevant branch of physical or engineering science. Strong preference will be given to candidates with a good reading knowledge of Russian.

Salary: In the range £2998-£5448 and a compensatory allowance (taxable but not superannuable) of 3.3% to offset personal contribution to Superannuation. Starting salary according to qualifications, experience and age. Promotion to higher scales on merit.

Application forms and full particulars from the: Executive Director,

Commonwealth Agricultural Bureaux,
Farnham House, Farnham Royal, Slough
SL2 3BN

Closing date for applications: 30 April, 1979.

Principal Animal Nutritionist

East Anglia, Car

This senior opportunity as Departmental Head—Ruminants, is based at our Nutritional Research Centre at Kennett near Newmarket. Reporting to the Research Controller, the successful applicant will plan and undertake studies in ruminant metabolism and nutrition. Current projects include raw material evaluation, protein and energy metabolism; blood biochemistry related to health and productivity of dairy cattle.

There is also close involvement with the company's laboratories working on feed advisory services and feed formulations and contact with larger users in the U.K. and abroad.

Applicants should have an honours degree in Agriculture/Animal Nutrition and have carried out research to a PhD level, with emphasis on ruminant nutrition. Aged 30 to 40 years, you will have had five years' research and commercial experience and be an effective communicator.

Salary is negotiable and excellent benefits include a company car, free lunches and a contributory pension scheme. Please write in confidence for an application form to: F. R. Hall, Personnel and Training Manager, Spillers Limited, Research and Technology Centre, Station Road, Cambridge. CB1 2JN



Spillers

PHYSICIST

Snowdonia

Salary £4230-£6215 per annum

The Central Electricity Generating Board is seeking a PHYSICIST to work at TRAWSFYNYDD NUCLEAR POWER STATION situated in the heart of Snowdonia.

The postholder will work on physical aspects of reactor operation, short and long term, and on optimisation of all the station's conventional plant.

Candidates should be well qualified in an appropriate discipline and have some knowledge of nuclear power station practice.

Applications in writing, from either sex, giving details of age, experience, qualifications etc. to the Personnel Manager, CEGB, NW Region, Europa House, Bird Hall Lane, Cheadle Heath, Stockport SK3 0XA to reach him no later than 28 March, 1979. Please quote vacancy 463/NS.



The New South Wales
Institute of Technology
Sidney, Australia

Associate Head

School of Computing Sciences

A\$30,796 — A\$33,061

Applications are sought for the second chair, newly established in the School of Computing Sciences within the faculty of Mathematical and Computing Sciences.

The school offers a Bachelor's Degree, in Computing Science, a Post-Graduate Diploma in Data Processing, and a Master's Degree by research and thesis. A Master's Degree in Information Science by course work will be introduced in 1980-1981. The school has a number of laboratories and a prime 350 computer. The Computer Centre has recently commenced the installation of a large Honeywell Network which will include a level 66, five level 6 computers and some 200 terminals. The school is active in research and consulting to industry.

The current academic establishment is 37 staff, divided into four specialist units: Computing Systems, Information Systems, Computing Methods, and Business Computing. The Associate Head of School should provide academic leadership in the area of information systems or computing systems.

Information systems presents subjects and has graduate students in the areas of file structures, data base management, systems analysis, data communications and networks, commercial programming, and management.

Computing Systems includes systems architecture, operating systems, languages and processors, performance evaluation, and microprocessors.

The successful applicant will have a Doctoral Degree and will have demonstrated leadership in one of the above fields. Industrial experience would be of considerable advantage. The Associate Head of School will have a major role in the planning of this rapidly developing school, and will be given specific responsibility for certain aspects of its administration.

Fares and a contribution toward removal and initial accommodation expenses are provided for overseas appointees. A housing loan scheme is also available. With permission of Council, academic staff are permitted to undertake limited consulting work.

Applications close on 30 March, 1979. Applicants should arrange for three confidential referee's reports to arrive by the same date. Applications should include: address; telephone number; personal particulars; documentary evidence of qualifications; work and teaching experience; affiliations; publications and the names and addresses of referees contacted. Further information may be obtained from, and applications and referee's reports are to be sent to: **The Agent-General for N.S.W., N.S.W. Government Offices, 66 The Strand, London WC2N 5LZ, England.**

**WELLCOME MUSEUM OF THE HISTORY OF MEDICINE
SCIENCE MUSEUM
LONDON SW7**

Appointments of Museum Assistants

Applications are invited from men and women for several posts in connection with the setting up of this Museum.

The posts are based at the Wellcome Store at Enfield, Middlesex, the Science Museum, London SW7 and at Euston Road NW1 being for an initial period of one year. There is a possibility that the appointments may be extended to a total of not more than five years. They are funded by the Wellcome Trustees and are not Civil Service appointments.

Candidates for these posts should have a sense of history and an interest in the purpose of the Museum. Applicants should normally have at least four passes at the Ordinary Level of the General Certificate of Education or at the Ordinary Grade of the Scottish Certificate of Education; these should include English or English Language and either Mathematics or a Science subject. Clear handwriting is essential. Principal duties involve the careful handling of a wide range of objects (some of which are heavy) relating to the history of medicine to facilitate the work of Cataloguers.

Starting salary according to age from £1775 at age 16 to £2731 at age 22 or over plus an Inner London Allowance of £524 (for the posts at the Science Museum and Euston Road) and an Outer London Allowance of £275 for the posts at Enfield. Point of entry will be determined by the age and experience of the candidate.

No pension scheme applies to these posts but service of more than two years will attract a Short Service payment on completion of the appointment.

For an application form (to be returned by 9 April, 1979) call phone or write to **The Staff Section, Science Museum, Exhibition Road, London SW7 2DD, 01-589 3456 Ext 594.**

Thick Film Hybrids MATERIALS RESEARCH

Northern Home Counties c £6000

An ideal opportunity now exists for an experienced Materials Research Scientist anxious to pursue and broaden his or her career within one of Europe's leading high-technology engineering research centres.

As part of a team with a high reputation in the field, responsibilities will be centred around the selection and evaluation of new materials, components and related processes required to meet current and future thick film hybrid circuit needs. Such circuits are manufactured primarily by the company's numerous production facilities both in Europe and the USA. Other areas of activities will include the investigation and analysis of failure mechanisms, taking advantage of extensive analytical facilities, as well as work on the packaging of hybrids.

Applicants should be qualified to Degree level in Physics, Chemistry of Materials Science and preferably have some relevant experience of hybrid micro-electronics and/or component evaluation.

If you're looking for career progression and more challenging assignments, then either write in confidence or telephone for an application form quoting Ref/TFH to:

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JACQUES SAMUEL & ASSOCIATES LTD
Technical & Management Recruitment Consultants
33 Bancroft, Hitchin, Hertfordshire
Business hours telephone Hitchin 54761/2
Evenings/weekends telephone Welwyn 4256



UNIVERSITY OF EDINBURGH POSTGRADUATE RESEARCH IN COMPUTER-BASED EDUCATION

Applications are invited from graduates (and prospective graduates) who wish to read for a PhD degree in computer-based education. The particular interests of the department have been problems of remedial and special education, and the integration of computer programming into the study of mathematics at both primary and secondary levels.

Preference will be given to candidates with a First or Upper Second Class Honours degree in Education or Psychology, or in Computer Science or Mathematics with a strong interest in educational problems. Teaching or other practical experience would also be an advantage.

Successful applicants will be nominated for earmarked SSRC Postgraduate Studentships.

Further information can be obtained by letter to:

Dr J. Howe, Department of Artificial Intelligence, University of Edinburgh, Forrest Hill, Edinburgh EH1 2QL.



Tayside Regional Council

PUBLIC ANALYST'S DEPARTMENT

SENIOR ASSISTANT ANALYST

£4608-£5754 plus £312 pay supplement

(Ref: 608/78)

Location: Public Analyst's Laboratory, 140 Perth Road, Dundee.

Ideally, applicants should be Chartered Chemists and members of the Royal Institute of Chemistry with at least 3 years' experience of working in a Public Analyst's laboratory or similar analytical laboratory. Placing on the above scale will be dependent upon experience. Closing date for receipt of applications is Friday, 20 April, 1979.

Application forms are obtainable from, and returnable to, the **PRINCIPAL PERSONNEL OFFICER, 15 Albert Square, Dundee. For enquiries, telephone Dundee (0382) 23281 Ext 3881. Candidates of either sex may apply.**

A vacancy exists for an ELECTRONICS ENGINEER

to join the Biomedical Engineering Department of King's College Hospital Medical School.

The successful applicant will join a multi-disciplinary team working on a variety of research projects. Much of the Department's work is concerned with the design and development of specialised instrumentation for diagnosis and therapy and the Department has a special interest in peripheral vascular disease, and automated chemical analysis.

The person appointed to this post will probably have a good degree or HND in electronics or electrical engineering and have had a period of industrial training and / or served a recognised apprenticeship. Experience of constructional methods and the ability to handle analogue and digital techniques will be expected. The successful candidate will also be expected to be adaptable and to show initiative.

The post, which is for one year in the first instance, is superannuated and it is anticipated that it will be extended for a second year.

Salary will be in the range: £2991-£4899 + £354 London Weighting. Placement will depend on age and experience.

Application form and job description available from the District Personnel Department, King's College Hospital, Denmark Hill, London SE5 9RS. Tel: 01-274 6222 ext 2254. Closing date: 23 March, 1979.

RESEARCH CHEMIST

A Research Chemist to work in the areas of co-ordination and bio-inorganic chemistry is required for research, in the first instance, into the chemistry of molybdenum iron-sulphur cluster systems and related species.

The post is in the Higher Scientific Officer grade, on a salary scale increasing from £4101 to £5448 per annum, by 8 yearly increments.

Qualifications: 1st or upper 2nd class honours degree with at least 2 years relevant post graduate experience.

Superannuation under a non-contributory scheme.

Applications in writing to the Secretary, Agricultural Research Council, Unit of Nitrogen Fixation, University of Sussex, Brighton, Sussex BN1 9RQ, with curriculum vitae and the names of three referees. Closing date: 30 March, 1979.

QUEEN ELIZABETH COLLEGE

Kensington
(University of London)

Physiology Department
TECHNICIAN GRADE 4

A vacancy has arisen for a technician grade 4 to assist in a project concerned with the characterisation of renal damage induced by sucrose diet. Animal experience is essential but some biochemical laboratory experience would also be an advantage. The post, supported from outside funds, will be tenable on a contract running until 31 March, 1980.

Salary, including London Weighting, within range £3420-£3890 (under review).

Contact Mrs G. Howard, Queen Elizabeth College, Campden Hill Road, London W8 7AH, for application form. Tel: 01-937 5411 ext 499.

After a year with us, most Organic Chemists will have several years of experience.

Sterling Organics is in a position to offer you a great deal of experience-in a comparatively short time. As part of Sterling Drug Inc., one of the largest pharmaceutical groups in the world, we manufacture a very wide range of bulk pharmaceuticals, customer-synthesised organic chemicals and intermediates. Our sophisticated plant and considerable R&D resources mean that our list of products and clients is growing and when you work with us that means new challenge and new experience every day.

To keep pace with expansion, we're looking for additional shift Organic Chemists. With the overall aim of increasing productivity, you'll ensure that processes are carried out correctly and that work is done according to schedule. In your role as a trouble shooter, you'll be constantly scrutinising the production process to ensure quality and the elimination of any problems.

The people we're looking for will be aged between 21 and 35 and qualified to at least HNC or possibly a recent chemistry

graduate. You'll preferably have gained relevant experience probably in a smaller operation where you'll also have been in charge of a small team of Operatives. However, if you've just graduated, we'll still be interested in you. Most important of all will be your questioning mind and your ability to anticipate and thus prevent problems. Overseeing several processes at once will call for a flexible approach and an agile mind.

The rewards include a competitive salary and shift allowance, good pension scheme and generous relocation expenses where appropriate. The scope of in-depth experience you'll gain and the company's exciting expansion plans guarantee excellent prospects for the future. So leave your contemporaries behind-certainly in terms of experience -and contact:

**Alan Dellow, Personnel Officer,
Sterling Organics, Dudley,
Nr Cramlington, Northumberland.
Tel: Dudley 471**

Applications welcome from both men and women

Sterling Organics

Electron Microscopist

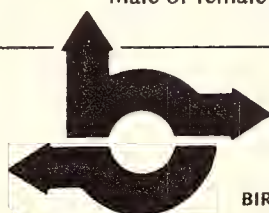
East of Scotland, to £6,500

This metallurgical appointment contributes directly to the quality of products used in demanding advanced technology applications. Responsibilities cover investigation, identification and analysis of metallurgical structures utilising TEM, SEM and energy dispersive analysis techniques to support recommended methods of manufacture. The ability to relate results to production processes is vital as is the

ability to communicate effectively. The ideal applicant should have a degree in Metallurgy and direct experience of transmission and scanning electron microscope equipment. The company are prepared to train those people who fall short of this ideal but wish to develop their career in this key area. The conditions of employment reflect the status of the company and include generous assistance in relocating to a pleasant area.

J.C. Brown, Ref: 31407/NS

Male or female candidates should telephone in confidence for a Personal History Form to:
GLASGOW: 041-221 2585, 127 St Vincent Street, G2 5JR.



Hoggett Bowers
Executive Selection Consultants

BIRMINGHAM, CARDIFF, GLASGOW, LEEDS, LONDON, MANCHESTER, NEWCASTLE and SHEFFIELD.

Research Archivist

As one of the largest pharmaceutical companies, Hoechst operates on a world-wide scale and the UK Research Laboratories play an integral part in the company's activities. At our new Research Laboratories at Milton Keynes, Bucks, we have a challenging vacancy for a Research Archivist.

This involves responsibility for maintaining a central archive for all laboratory data and providing information services to a group of multi-disciplinary Scientists. It offers an ideal opportunity for an Information Scientist or Graduate Scientist with information services experience to start a career.

The ideal candidate will be familiar with handling questions in organic chemistry.

This appointment carries a good salary, with at least four weeks holiday a year. Benefits include flexible working hours, free private health scheme, subsidised restaurant meals, excellent sports and social facilities. Generous relocation assistance will be provided if applicable.

Please write or telephone for an application form to:
Mr. A. Forrest, Personnel Department, Hoechst UK Limited,
 Walton Manor, Walton, Milton Keynes, Bucks.
 Tel: Pineham 5068.

Hoechst



Opportunity in Technical Publishing

We have a vacancy for an

ASSISTANT EDITOR

in our Publishing Department, at Stevenage, which produces a wide range of material including technical journals, learned-society periodicals, books, etc. This is a progressive appointment. We are looking for a young man or woman with a good command of English and with a degree or equivalent in Engineering (preferably Electrical or Electronics), Physics or Maths. Some experience of editing or publishing would be most helpful, but if you have a relevant degree we are prepared to train you. The interviews will contain questions to test your aptitude for this sort of work.

Modern office accommodation, flexible working hours, four weeks annual holiday, contributory pension scheme, luncheon vouchers and subsidised staff restaurant.

Please write with sufficient details to:

J. D. St Aubyn,
 Editor in Chief,
 The Institution of Electrical Engineers,
 Southgate House,
 Stevenage, Herts.

MEDICAL RESEARCH COUNCIL

RESEARCH ASSISTANT

(Technician/Research Officer—
 Salary scale £3261-£4902)

The MRC Clinical Psychiatry Unit requires a Psychologist or Social Science Graduate, with some training in Statistics, to join a small team working on clinical and epidemiological studies of psychiatric illness. The applicant will be expected to assist with the analysis and interpretation of data derived from clinical studies and a psychiatric case register; familiarity with or an interest in the use of an advanced desk top calculator would be an advantage. The main interests of the Unit are suicide and attempted suicide, depression and the neurophysiology of mental illness.

The person appointed will receive training in research methods and be encouraged to develop an individual interest in specific aspects of the work. Salary will depend on experience. The post becomes vacant on 1 June, 1979, and is for the duration of three years.

Applications to the Director, MRC Clinical Psychiatry Unit, Graylingwell Hospital, Chichester, Sussex PO19 4PQ, enclosing curriculum vitae and the names of two referees. Closing date for applications: 20 April.

AGRICULTURAL RESEARCH COUNCIL INSTITUTE OF ANIMAL PHYSIOLOGY, BABRAHAM, CAMBRIDGE CB2 4AT

A vacancy exists in the Immunology Department for a

RESEARCH SCIENTIST

who has made a significant contribution to the field of cellular physiology of the immune response. The candidate should be experienced in the analysis of lymphocyte and macrophage kinetics *in vivo*, with particular reference to cells engaged in the immune response, and in the induction and maintenance of tolerance. Applicants should have a first or upper second class honours degree and preferably a PhD in a relevant subject. Appointment as Principal Scientific Officer—£6609-£8461 pa. Non-contributory superannuation scheme. Applications should be sent to the Secretary of the Institute by 2 April, 1979 quoting Ref. I.D.4.

McVITIE'S K.P. FOODS KEEBLER (U.S.A.)

Microbiological Supplies Technician

United Biscuits is one of the leading food groups in the world with a turnover in excess of £600m, and operates principally in the UK and USA.

The above vacancy has arisen in our Frozen Foods Company, based at Isleworth. Main responsibilities include stock control, media preparation, media quality control, and some microbiological testing.

Applicants, male or female, must have had 1-2 years' practical

experience and hold an ONC or equivalent in Science subjects.

Benefits include attractive salary, 4 weeks' holiday, generous pension scheme, staff shop, hairdressers, car parking, etc.

Write or telephone for application form to:

Miss P. Jung, United Biscuits (UK) Limited, Syon Lane,
 Isleworth, Middx TW7 5NN.

Tel: (01) 560 3131.

United Biscuits (UK) Limited

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CORNWALL AND ISLES OF SCILLY AREA HEALTH AUTHORITY

AREA PHARMACEUTICAL SERVICE

APPLICATIONS ARE INVITED
FOR THE POST OF

ANALYST

(Scientific Officer Grade)

Salary Scale £2991 to £4275

Based at Camborne/Redruth Hospital, Cornwall

The duties of this post are to undertake a wide range of chemical and instrumental analyses on drug substances from both commercial and 'In House', this is an interesting job in a developing service and we are looking for an applicant of graduate, or equivalent level with an interest in the pharmaceutical analysis; some experience in this, or a closely allied field would be an obvious advantage.

The facilities are good with an extensively equipped laboratory servicing the needs of three pharmacy departments and a central manufacturing unit.

Further details of the post may be obtained from Dr J. F. Pickup, Staff Pharmacist at the Royal Cornwall Hospital, Treliske, Truro, to whom the appointee would be directly responsible.

DIVISION HEAD- PATHOLOGY

Applications are invited for this senior post within IRI. The Division Head is responsible for the scientific, financial and administrative control of the Division, which provides a full range of haematology necropsy and histopathology services on a wide range of laboratory animals. Additionally, it involves areas of experimental pathology/toxicology and animal health.

Candidates should have a medical or veterinary degree and postgraduate training in pathology, with the proven ability to manage staff and resources. Experience in a commercially-oriented environment would be a particular asset.

IRI is located in pleasant surroundings on the outskirts of Edinburgh. The post carries a range of modern employment benefits including a car and relocation assistance. Application forms, quoting ref. 2405, are available from



Miss J. M. Dunbar,
Inveresk Research
International,
Inveresk Gate,
Musselburgh EH21 7UB.

MICROBIOLOGIST

We are a well known manufacturer of proprietary pharmaceuticals and toiletry products urgently seeking a microbiologist of HNC or similar qualification.

Aged about 25, he/she will have had at least a year's relevant experience in the pharmaceutical, toiletry, food or water industries.

The post is within our spacious and well equipped Quality Control Department in a very modern factory with excellent facilities.

The job is challenging and requires a person with initiative and a pleasant authoritative manner. The appointed young man or woman will have sole responsibility for all aspects of microbiological testing and hygienic standards operational throughout the factory.

We are offering a starting salary up to £4000 per annum to the right candidate plus excellent fringe benefits and a 4½ day week.

Please write giving concise career details or telephone:

K. J. Franklin, Chief Chemist, Scott & Bowne Limited, Johnson Street, Southall, Middlesex. Tel. 571 2201.

Biochemists/ Biochemical Pharmacologists

Applications are invited from biochemists or biochemical pharmacologists at both BSc and PhD level, including newly qualified graduates, to join a project working in the field of occlusive vascular disease. The work will involve studying the effect of compounds on blood lipids and platelets in animal models of hyperlipidaemia, atherosclerosis and arterial thrombosis. Candidates with experience in radioimmunoassay and protein purification techniques would be preferred for one of the positions, otherwise previous experience in this area is not essential.

The successful candidates initially will be based at Walton Oaks but the team will relocate to our recently acquired biosciences research site—Gt Burgh—later in the year, Gt Burgh is near Epsom Downs, some 4 miles distant from Walton Oaks. Conditions of employment are first class and include flexible working hours.

A full cv should be submitted by 5 April. Alternatively an application form, returnable by the same date, may be requested from **Mrs M. R. Minchin, Site Personnel Officer, Beecham Pharmaceuticals Research Division, Animal Health Research Centre, Walton Oaks, Dorking Road, Tadworth, Surrey.** Telephone Tadworth 4444.

Beecham
Animal Health

UNIVERSITY OF GLASGOW DEPARTMENT OF ZOOLOGY

RESEARCH ASSISTANT

Applications are invited from graduates with a training in neurobiology to work on a project concerned with the function of interneurons in the connectives of the locust. The project is funded by the SRC and is supervised by Dr M. D. Burns.

The position will be for three years, with starting salary within £3384-£3883 (Range 1B, Research and Analogous Staff Scales). It may be possible to register for a higher degree. Application, enclosing curriculum vitae and the names of two referees, should be sent to:

Dr M. D. Burns,
Zoology Department,
Glasgow University,
Glasgow G12 8QQ.

In reply please quote Ref. No. 4392N.

The Queen's University of Belfast

CHAIR OF ZOOLOGY

Applications are invited for the Chair of Zoology which will become vacant on 1 October, 1979 on the appointment of Professor G. Owen as Principal of University College of Wales, Aberystwyth. The salary of the Chair is £10 575 per annum (under review) with contributory pension rights under FSSU or USS.

Further particulars may be obtained from the Personnel Officer, The Queen's University of Belfast BT7 1NN, Northern Ireland. Closing date: 27 April, 1979. (Please quote Ref. 79/NS)

THAMES POLYTECHNIC SCHOOL OF ARCHITECTURE AND LANDSCAPE

PART-TIME (TERM-TIME) ARCHITECTURAL SCIENCE TECHNICIAN

Architecture courses at degree and diploma levels are offered at Woolwich and preparations are in hand to install scientific equipment to aid environmental design teaching. Applications are invited from persons suitably qualified in a Science or Engineering discipline (minimum ONC/OND) with relevant experience, electrical/mechanical skills, and the imagination to help develop, maintain and use the equipment under lecturers' supervision. The ability to communicate effectively is essential.

The post, Grade 4, is part-time, 25 hours per week during term-time (36 weeks). Actual hours are negotiable.

Salary scale: Technician Grade 4 £1621-£1846 per annum inclusive.

Further particulars and form of application may be obtained from the Staffing Officer, Thames Polytechnic, Wellington Street, London SE18 6PF, to whom completed applications should be returned by 10 April, 1979.

UNIVERSITY OF SIERRA LEONE

Njala University College
The Department of
Mathematics

Applications are invited for the
post of

SENIOR LECTURER/ LECTURER

Appointees will be required to teach Mathematics or Statistics to prospective secondary school teachers and Agriculturists. For Senior Lecturer level, applicants should preferably be in possession of PhD in Mathematics with teaching experience of at least five years in an institution or institutions of higher learning or institutions involved in training graduate secondary school teachers. They must be able to teach up to at least first degree standard in at least any two of the following: Modern Algebra, Analysis, Topology, Geometry, Statistics, Applied Mathematics, and Methods Courses in Mathematics. For Lecturer level, applicants must be in possession of at least a good Honours or Masters degree and able to teach at least any two of the following courses to first degree standard: Calculus, Modern Algebra, Analysis, Geometry, Applied Mathematics and Methods Courses in Mathematics. Salary scales (under review); Senior Lecturer: £5678-£6910 per annum. Lecturer: £3740-£6270 per annum (£1 Sterling=£2.12). Family passages; superannuation or contract terms; outfit allowance £120 (where applicable) car allowance £600 per annum; annual leave; car loan negotiated; part-furnished accommodation at reasonable rental. Detailed applications (two copies) with curriculum vitae and naming three referees should be sent direct to the Secretary, University of Sierra Leone, Private Mail Bag, Freetown, Sierra Leone by 28 April, 1979. Applicants resident in the UK should also send one copy to the Inter-University Council, 90-91 Tottenham Court Road, London W1P 0DT. Further particulars may be obtained from either address.

UNIVERSITY OF STRATHCLYDE

PROJECT MASS— TEAM RESEARCH IN MARINE TECHNOLOGY

Applications are invited from suitably-qualified graduates in Metallurgy (with an interest in Welding) or from Post-graduates in Welding Technology for a RESEARCH ASSISTANTSHIP in the DEPARTMENT OF METALLURGY to join an existing multi-disciplinary research team involving six departments in the University to work on the challenging problems associated with underwater maintenance activities.

The appointee will be required to research into Underwater Welding problems in relation to offshore maintenance activities.

Project MASS has been initiated by the University of Strathclyde as a positive contribution to underwater maintenance research and is supported by a major grant from the Science Research Council. The work has the active backing of the Marine Industry.

Appointment to commence as soon as possible and initially until 30 September, 1980 with the expectation of extension subject to the agreement of both parties.

Commencing salary on Range IA (£3883-£6555) of the national salary structure for research and analogous staff, depending on age, qualifications and experience. Superannuation benefit.

Application forms and further particulars (quoting R10/79) may be obtained from the Academic Appointments Officer, University of Strathclyde, Royal College Building, 204 George Street, Glasgow G1 1XW, with whom applications must be lodged.



THE UNIVERSITY OF ASTON IN BIRMINGHAM

PROJECT PROGRAMMER

A vacancy exists in a research group which is constructing a bibliographic information system in conjunction with the Biodeterioration Information centre in the University. The project involves a variety of programming work, including the production of computer type-set output, software for a microprocessor-controlled data entry device and the implementation of sophisticated information retrieval algorithms. This post is for a period of eighteen months only, in the first instance. Applicants should be graduates with a good working knowledge of at least one high-level language, and preferably some experience of assembly level programming. Salary within Research & Analogous Staff £3384 - £3883. Application forms and further details to Mr. A.G. Rees, Staffing Department, quoting reference number 0/171/NS

The University of Aston in Birmingham

Gosta Green

Birmingham B4 7ET

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Zoology

The University invites applications for the post of
LECTURER

in the Department of Zoology, tenable from 1 October, 1979. Candidates should possess a higher degree or equivalent research experience, and preference will be given to those with experience in invertebrate neurophysiology. Applicants with other qualifications, particularly in ecology or entomology may also be considered.

Salary will be at an appropriate point on the Lecturers' scale: £3883-£7754 per annum, according to age, qualifications and experience. Membership of the appropriate University superannuation scheme will be required.

Further particulars may be obtained from the Senior Assistant Registrar, The University, 6 Kensington Terrace, Newcastle upon Tyne NE1 7RU, with whom applications (three copies), together with names and addresses of three referees, should be lodged not later than 9 April, 1979. Please quote reference NS.

UNIVERSITY OF ESSEX

FELLOW IN THE DEPARTMENT OF PHYSICS

Applications are invited for the SRC-supported post of Fellow (Range IA) in the above Department, tenable for three years starting as soon as possible (salary scale £3883-£6555, under review). The person appointed will be engaged in experimental studies of wave-wave interactions in laser-generated plasmas and will participate generally in the work of the Laser Plasma Interaction Group at the SRC Rutherford Laboratory Laser Facility.

Applications (three copies), including a curriculum vitae and the names and addresses of two referees, should reach the Registrar (AG/70/NS), University of Essex, Wivenhoe Park, Colchester CO4 3SQ, from whom further particulars may be obtained, by 5 April, 1979.

MERTON, SUTTON AND WANDSWORTH AREA HEALTH AUTHORITY (TEACHING)

Queen Mary's Hospital,
Roehampton,
London SW15 5PN
**LOCUM SENIOR
BIOCHEMIST**

Applications are invited for this post in Chemical Pathology at this busy University Hospital Laboratory. Candidates should have good all-round experience in clinical chemistry. The locum period will be from April to September and may be extended, depending on circumstances. Applications from Assistant Administrator, Queen Mary's Hospital, tel: 01-789 6611 ext 204, which should be returned as soon as possible.

Candidates may visit the laboratory by prior arrangement (ext 360).

Pay: £5451-£6837 plus £354 London Weighting.

TWO LABORATORY TECHNICIANS

required asap to work in the Biology and Physics Departments of this 3 fe Grammar School, reorganising since 1977 as 4 fe comprehensive. Substantial O and A Level work involved and trained technicians preferred, but appropriately qualified school leavers considered. Pay according to experience and qualifications; the present posts graded 2B are under review. Application forms from Headmaster, Westminster City School, 55 Palace Street SW1.

THE DEPARTMENT OF BIOCHEMISTRY

has a vacancy in the Junior Medical Laboratory Scientific Officer Grade to assist with undergraduate teaching, and research work involving cell culture and radio-isotopes. Apply in writing giving age and full details of education, qualifications or experience to the Chief Medical Laboratory Scientific Officer, Biochemistry Department, St. Thomas's Hospital Medical School, London SE1 7EH.

NEWCASTLE UPON TYNE POLYTECHNIC

Department of Mechanical
Engineering and Materials Technology

Research Assistant/ Associate

Required in the High Temperature Materials Research Group sponsored by the European Commission to investigate the high temperature corrosion behaviour of alloys in sulphur-bearing environments. Research Assistant post requires degree or equivalent qualification in Chemistry or Metallurgy/Materials Science and encourages study for higher degree. Research Associate post requires PhD and relevant experience. Grade of appointment depends on qualifications and experience but in either case the appointment is initially for one year with a probable extension of a further year.

Salaries:

Research Assistant: £3162-£3555 pa

Research Associate: £4101-£6558 pa

For further particulars and application form, returnable by 29 March, 1979, please send a stamped addressed foolscap envelope to the Staffing Officer, Newcastle upon Tyne Polytechnic, Ellison Buildings, Ellison Place, Newcastle upon Tyne NE1 8ST.

UNIVERSITY COLLEGE OF NORTH WALES

Applications are invited for the
post of

LECTURER IN AGRICULTURE

Applicants should have a degree in Agriculture, Agricultural Science or a related discipline, together with appropriate postgraduate experience in grass production and utilisation.

The appointment, to commence on 1 September, 1979, or any earlier date by agreement, will be to the Universities' Lecturer scale: £3883-£7754 per annum (under review).

Applications (two copies), giving details of qualifications and experience, together with the names and addresses of three referees should be sent to the Assistant Registrar (Personnel), University College of North Wales, Bangor, Gwynedd LL57 2DG, from whom further particulars may be obtained.

Closing date for applications: 2 April, 1979.

THE FOUNDATION OF THE INTERNATIONAL SCHOOL OF GENEVA

PHYSICS TEACHER

Required for September 1979 or January, 1980 to teach junior integrated science and physics to International Baccalaureate Higher level. Experience of recent curriculum developments and of use of a computer in physics education desirable.

Two year contracts: Salary scale Sfr35 655-Sfr53 746.

Letters of application, curriculum vitae, a recent photograph and current references should be forwarded immediately to the Recruitment Office, Foundation of the International School of Geneva, 1208 Geneva, Switzerland.

UNIVERSITY OF KEELE

TEMPORARY LECTURESHIP IN GEOGRAPHY

Applications invited for post of temporary Lecturer in Geography for one year from 1 October, 1979. Applicants should have interests in the application of numerical techniques to spatial problems.

Appointment will be made on the first three points of the Lecturers' scale, currently £3883-£4382 per annum, with membership of Universities Superannuation Scheme.

Further details and application forms from The Registrar, The University, Keele, Staffs., ST5 5BG, to whom they should be sent by 31 March, 1979.

THE OPEN UNIVERSITY
FACULTY OF SCIENCE



Assistant Cartographer (EARTH SCIENCES)

The successful applicant would be expected to prepare geological maps and diagrams for research publications, undergraduate courses, displays, meetings and symposia.

Applicants should have four years' practical cartographic experience, period of training inclusive. A recognised cartographic qualification would be desirable but proven ability to produce high quality artwork for reproduction (black and white and colour) is essential and shortlisted candidates would be expected to present a portfolio of their work at interview.

Salary on the scale £2955-£3402 pa (under review).

Ref: 3791

Research Technician (BIOLOGY)

Dr Richard Holmes requires a technician to assist his Research Group investigating Biochemical and Physiological variations in fish and amphibians. The post would suit someone able to work on their own initiative and wishing to be actively involved in an expanding research project.

Applicants should possess an HNC or equivalent and at least six years' experience in Biochemical or Biology Research.

Salary on the scale £3186-£3720 pa (under review).

Ref: 1983

Application forms and further particulars are available from the Recruitment Office (JD3790/4), The Open University, P.O. Box 75, Walton Hall, Milton Keynes MK7 6AL or telephone Milton Keynes 63404: there is a 24 hour answering service on 63868.

PLEASE QUOTE THE REFERENCE NUMBER OF THE POST IN WHICH YOU ARE INTERESTED.

Closing date for applications: 29 March.

STERLING



WINTHROP

SHIFT MANAGER— Tablets Manufacturing Department

Winthrop Laboratories Production Division has embarked upon a multi-million pound development programme which will include some of the most modern plant, equipment and facilities in Europe, the utilisation of which will be entrusted to persons of above-average ability.

Reporting to the Department Manager, the Shift Manager will be responsible for the efficient operation of the department during the shift, and it is anticipated that the successful applicant will have two or three years relevant experience.

The shift will operate on a basis of alternate weeks of 0600 - 1400 and 1400 - 2200 Monday to Friday. A shift allowance is payable.

An integral part of the Division's development programme is the construction of a completely new Tablet Manufacturing Department. The Shift Manager will be able to make a contribution to the design, layout and equipping of this new facility.

Candidates, male or female, should write, or telephone, for an application form to: Colin Davison, Winthrop Laboratories Production Division, Edgefield Avenue, Fawdon, Newcastle upon Tyne, NE3 3TT. Telephone: Newcastle 853931, Ext. 19.

WINTHROP

WINTHROP LABORATORIES

Winthrop Laboratories Production Division is the Pharmaceutical Manufacturing Plant for the Sterling-Winthrop Group, producing a wide range of well-known medicines for sale throughout the world.

PLYMOUTH
POLYTECHNIC
TECHNICAL SERVICES

TECHNICIAN T2 GEOGRAPHY

To work in the geography laboratories, especially biogeography and soils, preparing materials for teaching and research and assisting with field work.

Applicants should have had at least two years' experience in comparable laboratories and some knowledge of botany and/or chemistry would be an advantage. Two GCE 'A' levels, including geography are required, or an equivalent qualification.

Applicants should be over 21 years and hold a current driving licence.

TECHNICIAN T2 CHEMISTRY

To work in the chemistry laboratories assisting with the preparation of materials and equipment for teaching and research.

Applicants should have an ONC/OND or equivalent qualification together with at least two year's relevant experience (including training) and be familiar with modern analytical instrumentation. A knowledge of organic preparation techniques would be an advantage.

SALARY: £2967-£3339
(+ £312 PA SUPPLEMENT)

Application forms to be returned by Friday, 6 April 1979 can be obtained with further particulars for these posts from the Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA.

Scientific Officer— Clinical Chemistry

Huntingdon Research Centre is a contract research organisation, the largest of its kind in the UK, working in the safety evaluation of pharmaceuticals, biologicals and agrochemicals.

We need a Medical Laboratory Scientist who has a degree or AIMLS in clinical chemistry to join our team. You should have several years' experience and be able to work with minimal supervision. The laboratory is highly automated using both SMA 12/60 and Centrifchem. It is an ideal opportunity for someone wishing to broaden their experience of analytical techniques and develop their career in the field of animal chemical pathology. We could arrange for you to visit the Centre after your initial application but without a formal interview if you are interested in seeing how we work.

Salary is attractive and there are excellent benefits. The location itself has many advantages: Huntingdon is situated in pleasant countryside and housing prices are among the lowest in Britain. At the same time, you will be within easy reach, by road and rail, of Cambridge, London and the Midlands. Assistance will be given with relocation expenses.



Huntingdon Research Centre

For an application form please telephone or write to: Recruitment Officer, Huntingdon Research Centre, Huntingdon PE18 6ES. Tel: Huntingdon 890431.

THE OPEN
UNIVERSITY

Faculty of
Science



Research Assistantships in Chemistry

Applications are invited for full-time Research Assistantships in Chemistry, tenable from 1 October 1979 or before for three years, to work in the following subject areas:

Photochemistry of peptides and its relevance to chemical processes concerned with the origin of life; the investigation of energy transfer between carbonyl compounds and aromatic acceptors using laser flash photolysis; pulsed NMR spectroscopy in the investigation of ion-ion and ion-solvent interactions; the development of new synthetic methods based on organosilicon chemistry for the synthesis of compounds of pharmaceutical interest; iron-sulphur clusters as models for biological electron transfer agents; synthesis, X-ray diffraction, electron spin resonance and nuclear magnetic resonance.

Applicants should possess a good honours degree in chemistry or an equivalent qualification. Salary will be within the range £3384-£3883 pa on the Research Assistant 1B scale.

Application forms and further particulars are available from The Recruitment Office (JD3813/2), The Open University, P.O. Box 75, Walton Hall, Milton Keynes MK7 6AL or telephone Milton Keynes 63404: there is a 24 hour answering service on 63868.

Closing date for applications: 20 April.

Sales Representative - Chemicals Marketing

c. £6000 + Car

Continued company expansion and the increasing importance of radio-labelled compounds in many research techniques have created a need for an additional Technical Sales Representative. This post, based at Amersham, will involve close contact with universities, medical schools, research-based pharmaceutical companies and other organisations.

Representatives provide a vital link with our customers and candidates must have a good chemistry degree with either relevant sales/marketing experience or 2/3 years in an R. & D. environment and the ability to move into technical marketing.

The Radiochemical Centre is a world leader in the manufacture and marketing of a range of products for scientific research, medicine and industry. Growth has been consistently over 20% in real terms in recent years and group sales are now in excess of £33m. The company can therefore offer considerable career potential for the right candidate.

Starting salaries will be around £6000, including a productivity payment, plus a car. General conditions of employment are excellent and will include help with relocation costs where appropriate.

Please write with full career details to: Dr. J. S. Allinson, Personnel Officer.



The Radiochemical Centre
Amersham Bucks



1974

THE UNIVERSITY, MANCHESTER M13 9PL TECHNICIAN (Grade 4)

Department of Botany

Required to assist a group of plant ecologists in research and teaching. Current research includes studies of adaptation to nitrogen supply by upland pasture grasses and the effects of sulphur pollutants on the growth of mosses in the Southern Pennines. Duties will include the use of a wide range of analytical techniques including atomic absorption spectrophotometry. Some field work will be required. Applicants should hold ONC or equivalent and have at least 7 years' laboratory experience.

Applications, giving full details of age, qualifications and previous experience should be sent to Dr J. A. Lee, Department of Botany.

GRADE 4 SALARY SCALE £2955-£3402 pa. (UNDER REVIEW)

THE ROYAL VETERINARY COLLEGE University of London

Department of Surgery & Obstetrics,
Hawkshead Lane, North Mymms,
Herts.

TECHNICIAN GRADE 5

required to supervise a small endocrinology laboratory. Experience in the use of radio-isotopes and radio-immuno-assay essential. Interest in biological and clinical experimental work an advantage.

Salary scale: £3461 to £3995 p.a. (inclusive of London Allowance) (under review).

Application forms obtainable from Assistant Secretary (Personnel) The Royal Veterinary College, Royal College Street, London NW1 0TU (01-387-2898 Ext. 264).

SCOTTISH INSTITUTE OF AGRICULTURAL ENGINEERING

Head of Soils Section

Senior Scientific Officer/ Principal Scientific Officer (Ref. AG/18/B)

Re-advertisement

Applications are invited for the post of Senior Scientific Officer/Principal Scientific Officer to lead a team investigating the effects of agricultural machinery on the physical properties of field soils with particular reference to cultivation, zero-tillage and compaction.

Qualifications

A first or upper second class honours degree, and preferably a higher degree, or equivalent qualifications in a relevant branch of science or engineering. The applicant should have had considerable experience of research in soil physics or soil mechanics.

Salary Scales

Appointment in the grade of Senior Scientific Officer (£5154-£6898) or Principal Scientific Officer (£6609-£8461) according to qualifications and experience. Non-contributory superannuation.

Application forms and further information from the Secretary, Scottish Institute of Agricultural Engineering, Bush Estate, Penicuik, Midlothian EH26 0PH, to whom applications should be submitted by 2 April, 1979.

**PLYMOUTH
POLYTECHNIC**

**SCHOOL OF
ENVIRONMENTAL SCIENCES**

RESEARCH ASSISTANT PLANKTONIC INDICATORS

This externally funded project will initially be for six months and will primarily involve collation of existing data. However it is likely that there will be an extension to three years, (on a fixed term contract). The successful candidate would be encouraged to register for a higher degree.

Candidates should have a good degree in a suitable subject area and an interest in distribution aspects of marine plankton. Experience in this field and with appropriate statistical and computing techniques would be an advantage.

Salary will be £3192 for post graduates or £3468 for post doctoral (or equivalent) with annual increases of £138 when appropriate.

Application form to be returned by Friday, 6 April 1979 can be obtained with further particulars from the Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA.

MILES LABORATORIES

are an international pharmaceutical company based in attractive surroundings in Stoke Poges, Buckinghamshire.

We are currently seeking a
**PHARMACOLOGY
GRADUATE**

to join a team working on prostaglandins with special reference to their receptors in the respiratory tract.

Ideally we are seeking someone with a PhD qualification or alternatively an Honours graduate with one-two years post-qualification research experience in a related area.

Salary is negotiable and benefits include a thoroughly modern pension package including free life assurance, flexible working hours and subsidised staff restaurant.

Please write or telephone for an application form to:
Mrs Nancy Morgans, Personnel Manager, Miles Laboratories Ltd, Stoke Court, Stoke Poges, Slough. Tel: Farnham Common 2151.

UNIVERSITY OF LONDON

**Institute of Neurology
Department of Clinical
Neurology (Neurocytology)
TECHNICIAN GRADE 3:
ELECTRON MICROSCOPY**

New laboratories with facilities for TEM, SEM, STEM and X-ray microanalysis. The appointee will be expected to prepare biological materials for these techniques and should be a competent ultra-microtome.

Salary in the range £2688-£3060 (under review) plus £465 London weighting. The post to be tenable for 18 months in the first instance.

Apply in writing as soon as possible stating qualifications and experience to Dr D. N. Landon, Institute of Neurology, Queen Square, London WC1N 3BG.

HNC/HND in Chemistry?

Pesticide R & D will interest you

Synthesising new pesticides is challenging work. We at Shell Research Limited have several posts available immediately for Organic Chemistry Technicians to work on the synthesis of novel biologically active compounds.

If you are qualified up to the HNC/HND level, or have wide experience in chemical synthesis we would like to hear from you.

We offer a competitive salary and assistance will be given with relocation expenses where appropriate. You would be based at our Research Centre situated in pleasant rural surroundings near Sittingbourne and within travelling distance from several residential areas. You will be able to join our pension scheme, enjoy flexible working hours and make use of the excellent sports and social facilities. Please write giving all the relevant details about yourself and your career, or telephone for an application form to:

Mrs. I. Broodbank, Personnel Division (N2), Shell Research Limited, Sittingbourne Research Centre, Sittingbourne, Kent ME9 8AG. Telephone: Sittingbourne 24444, extension 203.



DIRECTOR

INSTITUTE OF MARINE SCIENCE
UNIVERSITY OF ALASKA

The University of Alaska, Fairbanks, invites applications for the position of Director, Institute of Marine Science and Division of Marine Sciences. Qualifications sought are a doctoral degree, leadership in interdisciplinary research management, experience in dealing with funding sources, and a knowledge of budgetary operations. A distinguished research record is expected. Experience in teaching and the supervision of thesis projects of graduate students is desirable. Marine Sciences at the University have a full-time faculty of 23 and a graduate student enrollment of about 40.

Applications or nominations with biographical and other pertinent information should be received before July 1, 1979, by the chairman of the search committee:

Dr Gunter E. Weller, Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701 USA.

The University of Alaska offers equal educational and employment opportunities.

UNIVERSITY OF BRISTOL
Department of Surgery

A vacancy exists for a

RESEARCH ASSISTANT

to work principally in setting up an investigation into the improvement of methods of long-term cryopreservation of human corneas. It is essential that applicants, who must be graduates, should have experience in techniques of tissue culture. The project is supported by the South West Regional Health Authority for a period of three years.

Starting salary will be up to £3634 per annum (scale under review). A curriculum vitae, with the names of two referees should be sent to Dr D. L. Easty, The Department of Surgery, The Medical School, Bristol DS8 1TD by 30 March, 1979.



Anglian Water Authority

Trade Effluent Inspector

Post Ref. S60194

Grade 5

£4323-£4850 pa (plus a supplement of £312 in accordance with the Government's pay policy)

Responsible for implementing trade effluent control in Eastern Suffolk including Ipswich. The post will be based at the Southern Area Office of the Norwich Sewage Division in Raeburn Road, Ipswich.

The duties of the post will include inspection of trade premises in respect of trade effluent problems, routine sampling of trade effluents and interpretation of analytical results. The job involves negotiations with traders on all aspects of trade effluent control and therefore requires someone who is able to discuss problems with traders in a tactful manner. The Trade Effluent Inspector is responsible for calculation of trade effluent charges. From time to time a certain amount of laboratory work may be involved.

Suitable candidates for the position will possess a BSc in Chemistry or HNC plus at least three years experience. A knowledge of sewage treatment processes is essential and an understanding of trade effluent control legislation is desirable. Corporate membership of the IWPC would be advantageous.

A clean, valid driving licence is essential. The post carries a regular user car allowance.

Application forms, which are to be returned by Friday, 30 March, 1979 are obtainable from the Divisional Finance/Admin. Officer at the address below. (Telephone Norwich 615161 ext. 244.)

NORWICH SEWAGE DIVISION,

Yare House, 62/64 Thorpe Road, Norwich NR1 1SA

FLOUR MILLING AND BAKING
RESEARCH ASSOCIATION

Engineer/Physicist

FMBRA wishes to appoint a young technologist to participate in energy surveys in flour mills and bakeries. The candidate should be qualified in engineering or physics, e.g. by possession of an HNC or degree, and preferably have 1-2 years' experience in industry. The appointment is a permanent one and will lead on to the more general application of physics and/or engineering to milling and baking problems. The work envisaged in the first two years will involve visits to a number of mills and bakeries in the UK, and will include discussions with mill and bakery managers.

Salary scales are under review by the starting salary offered will probably be in the range £4000-£5000 per annum, depending on qualifications and experience. Please write to the Secretary giving details of age, education and experience.

The Secretary, Flour Milling & Baking Research Association, Chorleywood, Rickmansworth, Herts.

THE UNIVERSITY
OF LEEDS
DEPARTMENT OF
PLANT SCIENCES

Applications are invited for the post of
EXPERIMENTAL OFFICER

to assist with research in the Department of Plant Sciences at the University's Field Station. Candidates should have a degree in an agricultural or biological science with a good background in chemistry or an appropriate qualification in analytical chemistry. The appointment will be made for a fixed term of two years.

Salary on the 1B grade for Other Related Staff: £3384-£5604 (under review) according to age, qualifications and experience.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 53/9/E. Closing date for applications 11 April, 1979.

Research & Development Chemist

ABERDEEN

£9,000 p.a. (negotiable) + CAR

A British Drilling Fluids Company who have established an excellent reputation in the North Sea Oil Industry are expanding their operations to cover growing commitments. In order to improve their existing high standard of service, our client now wishes to appoint a chemist who will be responsible for developing and improving the wide range of products already on offer.

It is preferable that candidates should have in-depth experience of oilfield technology; however, applicants with experience in Polymers, Lubricants, Detergents, Surfactants, Emulsions and Clay chemistry will be considered. After being made familiar with the use of drilling fluids in the Oil Industry, the chemist, working in the onshore laboratory, will be expected to develop his own new product ideas.

In addition to a BSc. in Chemistry, the successful candidate will have a high level of intelligence and flexibility. He will demonstrate the ability to operate in a highly competitive commercial market and be able to communicate well with clients in an advisory capacity.

A rent free, 2 bedroomed company house will be available for a limited period of time but relocation to Aberdeen is essential and assistance for this will be given.

A free telephone; limited expense account; 4 weeks annual holiday and an excellent pension scheme also adds to this extremely attractive package.

If you can meet the challenge of this demanding but interesting position, please contact:

GTS

Margaret Duthie,
Grampian Technical Services Ltd.,
27 York Place,
Aberdeen.
Tel: (0224) 28921

Licence No. SC.144

Grampian Technical Services Ltd.

ST THOMAS' HEALTH DISTRICT (TEACHING)

London SE1

GLAUCOMA/OPHTHALMIC TECHNICIAN

To work in the Courage Laboratory, Royal Eye Hospital with one of the Senior Consultants in Ophthalmology.

This interesting post involves the determination of visual function in Visual Fields, Macular Function, Colour Vision, Dark Adaptation and Glaucoma.

Qualifications: Institute of Ophthalmology training together with two years relevant experience or ONC in Physiological Measurement. However candidates without formal qualifications but with previous experience are also invited to apply.

Applicants without the above experience / qualifications may be considered as Student Technicians and specialised training will be given.

Salary for qualified Technician on scale £3270-£3933 per annum (inclusive).

Contact Ms J. Frost, Personnel Officer, St Thomas' Hospital, London SE1 7EH. Tel: (01) 928 9292 ext. 2779 for job description and application form. Closing date: 26 March, 1979.

University of Edinburgh
and Lothian Health Board

Department of Medical Physics
and Medical Engineering

Applications are invited for a post of

RESEARCH ASSISTANT

for a fixed period of two years. Applicants should have a good honours degree in physics. The successful candidate will join a team studying and applying physical techniques to measure the bone mineral content of patients and will be particularly concerned with the development of gamma ray attenuation methods in the spine and whole body. Data processing by computer will be necessary.

The appointment is on the Basic Grade Physicist scale, £3486-£4899 p.a. and Whitley Council conditions of service apply.

Applications which should be typewritten giving particulars of age, qualifications and previous experience together with the names and addresses of two referees should be lodged with the Secretary, 11 Drumcruagh Gardens, Edinburgh EH3 7QG, within two weeks from the date of this advertisement.

THE POLYTECHNIC: WOLVERHAMPTON SENIOR LABORATORY TECHNICIAN GRADE T3/4

A vacancy exists for a Senior Laboratory Technician to work in the physiology section of the Department of Biological Sciences.

Good qualifications and relevant experience in animal physiology are required, and preference will be given to candidates with appropriate electronic expertise.

Salary range: £3720-£4632 including supplement, and up to £72 per annum qualification allowance.

Starting point on scale dependent upon age, qualifications and experience.

Application forms and further details available from: Personnel, The Polytechnic, Wulfruna Street, Wolverhampton WV1 1LY.

SPECIFIC PROTEIN REFERENCE UNIT

PUTNEY HOSPITAL, THE LOWER COMMON, PUTNEY SW15 1HW

LOCUM BASIC GRADE BIOCHEMIST

required to work at the above unit to help with specific protein assays. Previous experience in field not essential. Initially the post is available from now until end of April 1979 with possibility of extension. Further details and arrangements to visit the unit may be made by contacting Miss Orr, Senior Biochemist, telephone 01-789 6633 extension 257 or 279. Application forms available from Unit Administrator extension 216.

UNIVERSITY OF STRATHCLYDE
DEPARTMENT OF APPLIED MICROBIOLOGY

PROFESSORSHIP IN APPLIED MICROBIOLOGY

Applications are invited from suitably qualified persons for full-time appointment to the Professorship in Applied Microbiology which will become vacant on 30 September, 1979, on the retirement of Professor E. O. Morris.

The post will be remunerated within the Professorial range for universities with USS benefits.

Application forms and further particulars (quoting 12/79) may be obtained from the Registrar, University of Strathclyde, Royal College Building, 204 George Street, Glasgow G1 1XW, with whom applications must be lodged by 6 April, 1979.

GAS PHASE STUDIES

Vacancies have arisen in our Materials Science Division for young graduates for gas phase studies. The work relates to investigation of a wide range of materials, product and process problems and calls for innovative ability.

Applicants should be in the age range 21-30 and have an Honours degree in Chemistry or Grad. R.I.C. For one post an interest in electrochemistry would be an advantage.

Please apply to: G. D. Prichard, Administration Manager (Ref. P/035), GEC Hirst Research Centre, East Lane, Wembley, Middx. HA9 7PP. Tel. 01-904 1262 Ext. 210.

UNIVERSITY OF LIVERPOOL

COMPOSITES FOR AUTOMOBILES

Department of Metallurgy and Materials Science

An important factor limiting the use of plastic based composites for the construction of road vehicles is their performance under crash conditions. In an attempt to reduce this limitation a number of industrial companies and the Polymer Engineering Directorate of the Science Research Council are jointly sponsoring a major investigation into design and testing of composite materials and structural components made from them.

Applications are sought from engineers, material scientists, physicists and chemists who believe they could contribute to investigations of the following:

1. Development of composites capable of absorbing relatively large amounts of energy before rupturing.
2. Development and application of techniques for measuring the rupture properties of composites under conditions of controlled high strain rate.
3. The design and testing of full scale simulated vehicle structural members made from composites.
4. Interpretation of test results at both micro and macro levels using electron optical, X-ray and other physical techniques already available in the Department.

Four posts of Research Fellow or Research Associate are available at salaries on scales extending from £3883-£9263 per annum with USS pension benefits. The project is financed for three years.

Application forms and further particulars may be obtained from The Registrar, The University, PO Box 147, Liverpool L69 3BX, by whom completed forms should be received not later than 13 April, 1979. Quote Ref: RV/524/NS.

Horticulturalist

required for exciting new project in United Arab Emirates. Young, qualified and adventurous professional required on a two year Contract to establish a new nursery, produce tree and shrub stock and supervise the landscape planting of a major prestige project.

Excellent salary, good living conditions and company vehicle provided.

Please apply in writing giving full details of qualifications and experience to

**The Technical Director,
8 Wood Street,
Stratford-on-Avon,
Warwickshire
CV37 6JE.**

Technician

£3459-£3831

Ewell

For the Department of Biological Studies at North East Surrey College of Technology. To prepare degree equivalent practicals and project work, and generally responsible for one of the Microbiology Laboratories.

Candidates should have at least two years practical experience in Microbiology and hold either HNC, Advanced City and Guilds or an equivalent qualification.

36 hours a week, with 19 days paid holiday plus 10 statutory holidays. Staff Restaurant and Car Park.

Application form from the Chief Administrative Officer, North East Surrey College of Technology, Reigate Road, Ewell, Epsom, Surrey KT17 3DS. Tel: 01-394 1731, Ext. 281. (Please quote ref: CAO/TBS/50.)



SURREY
COUNTY COUNCIL

SOUTH GLAMORGAN HEALTH AUTHORITY (T)

University Hospital of Wales

Physicist or Electronics Engineer

Required to undertake research into the provision of standard test and calibration devices for use with Diagnostic, Ultrasound Equipment. This post is for a period of one year in the first instance. Alternating a 2 year appointment is possible at normal Research Studentship rates. An opportunity will be provided for suitable candidates to register for a higher degree. Qualifications: Good Honours Degree in Physics Electronics or a related physical science.

Salary: £2991-£3486 according to qualifications and experience. Application forms from Personnel Department, University Hospital of Wales, Heath Park, Cardiff. Tel: 0222 755944 ext. 2917.

Further details from Mr K. McCarty, Senior Physicist, Tel: 0222 755944 ext 2740.

Closing date: 30 March, 1979.

A well known Pharmaceutical Group located in Paris requires a

RESEARCH SCIENTIST

for its Mass Spectrometer who will be responsible for:

- Operating a Gas Chromatograph—Mass Spectrometer—Data System. He will also assist non specialist users to operate the system and interpret their results.
- Carrying out routine maintenance, performing minor repairs and maintaining adequate stocks of spare parts.
- Purchasing and preparation of Gas Chromatography Columns (both packed and capillary), selecting the appropriate column for each analysis and assisting in the development of analytical methods.

Applicants should be suitably qualified and have at least 2 years experience of Analysis of Trace Metabolites by gas chromatography. Experience with mass spectrometry would be an advantage as well as an ability to operate complex equipment. Fluent French not required but appreciated, English would be an advantage.

Applications will be treated in the strictest confidence and should be sent to Box D367.

AGRICULTURAL RESEARCH COUNCIL
INSTITUTE OF ANIMAL PHYSIOLOGY,
BABRAHAM, CAMBRIDGE CB2 4AT.

NEUROBIOLOGICAL RESEARCH

As part of an expanded programme of work in Neurobiology at Babraham the following three new research appointments are available at Senior Scientific Officer level.

N.B.1. Peptide chemist for research in Neuroendocrine Group on peptidergic neurones. Candidates should have experience in isolation and characterisation of neuropeptides and an interest in collaboration with neurophysiologists.

N.B.2. Behavioural physiologist to investigate brain mechanisms in motivational behaviour of farm animals.

N.B.3. Neurophysiologists for research involving single unit neuronal recording from conscious animals to study neural mechanisms in ingestive behaviour of farm animals.

Candidates should possess a first or upper second class honours degree together with at least four years relevant postgraduate experience, with preferably a PhD degree and a good record of published work. Salary £5154-£6898 pa. Non-contributory pension scheme.

Application forms and further details may be obtained from the Secretary of the Institute by quoting the appropriate reference No. Closing date for applications 2nd April, 1979.

THE BETHLEM ROYAL HOSPITAL

Department of Clinical Chemistry

MEDICAL LABORATORY SCIENTIFIC OFFICER

required in the Therapeutic and Diagnostic Drug Laboratory. This laboratory provides a growing routine service for a number of Teaching Hospitals. Previous experience in drug assays is not essential as training will be given in the Techniques used in this well equipped laboratory currently performing TLC, GLC and Immunoassays. The post will involve advising clinicians on the interpretation of results.

Applicants should have HNC in Clinical Chemistry, a suitable degree or other qualifications.

Salary £3615 to £5034 depending on experience.

Application forms available from Senior Chief MLSO, Department of Clinical Chemistry, Bethlem Royal Hospital, Monks Orchard Road, Beckenham, Kent.

Phone: 777-6611 ext 16.

DEVELOPMENT OFFICERS

Foseco International Limited carries out research and development for a large multinational Group, which develops, manufactures and markets chemical products to a wide range of industries.

The Materials Division now has openings for people qualified to degree or HNC standard in physics, chemistry or materials science.

- (a) to join a small professional team presently working on refractories and high temperature insulation materials (two posts). The successful applicants will work on a variety of projects from conception through to final manufacture, including assessment in the field.
- (b) to identify and solve process control problems in both financial and technical terms, including the development and establishment of test methods (one post).

The ability to communicate at all levels, personal flexibility and a broad commonsense outlook are essential qualities for all these posts. Good salaries and benefits will be offered together with assistance in relocation expenses where applicable.

Please apply to, Mr. N.J.M. Bennett, Group Personnel Manager, Foseco International Limited, 285 Long Acre, Nchells, Birmingham B7 5JR.



Foseco

INTERNATIONAL LIMITED

A MEMBER OF THE FOSECO MINSEP GROUP



UNIVERSITY OF KENT AT CANTERBURY RESEARCH ASSISTANT IN MICROBIOLOGY

Applications are invited for the post of Research Assistant to work on a project supported by the Agricultural Research Council concerning the breakdown of cellulose in soil, particularly as it applies to the spatial relationships between micro-organisms, enzymes, substrates and soil particulates, under the supervision of Dr R. G. Burns. The appointment is tenable for three years and a suitably-qualified applicant would have the opportunity of registering for a PhD degree. Applicants must have, or expect to obtain a first or upper second class honours degree in microbiology, biochemistry or a closely-related subject. Salary range £3384-£3883.

Particulars and application forms may be obtained from the Senior Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University, Canterbury, Kent CT2 7NH, to whom completed applications should be returned by 6 April, 1979. Please quote reference A20/79.

KINGSTON GRAMMAR SCHOOL HMC INDEPENDENT (575 boys and girls)

A full time

TECHNICIAN/ ASSISTANT

is required to work in the PHYSICS department and to assist with the use of the AUDIO-VISUAL equipment in the School.

It is hoped to appoint a person with appropriate experience and/or qualifications, but further training may be available on a day release basis for an otherwise suitable applicant.

Salary will be in line with current technical scales, with London allowance.

Full details and application forms from:—
The Headmaster, Kingston Grammar School, 70 London Road, Kingston upon Thames, Surrey KT2 6PY.

Northern Regional Health Authority Regional Medical Physics Department Newcastle General Hospital

Senior Grade Physicist (Radioisotopes)

Applications are invited from Physicists with considerable experience in the diagnostic application of radionuclides to be responsible to the Head of the Radiation Physics Section for the non-imaging activities of the Department.

The Department provides a comprehensive radioisotope service and has a vigorous research and development programme. It is the centre of advice for all aspects of radionuclide useage in the Northern Region. It enjoys close collaboration with most of the clinical specialities in the Teaching hospital group.

The successful applicant will be expected to contribute substantially to the research programme on metabolism and body composition in collaboration with clinicians, and personal research will be encouraged. In-vivo activation analysis facilities may become available in the foreseeable future to complement the existing whole body monitor.

Candidates must have a good honours degree in Physics and considerable relevant experience.

Salary: £5451 per annum rising by annual increments to a maximum of £6837.

Further details may be obtained from Mr J. W. Haggith, telephone 0632-738811, Extension 630.

An application form and job description are available from: **The Regional Personnel Officer, Northern Regional Health Authority, Benfield Road, Walkergate, Newcastle upon Tyne NE6 4PY** to whom applications should be made by 30th March, 1979.

**LONDON SCHOOL OF
HYGIENE AND TROPICAL
MEDICINE**
(University of London)
Keppel Street, WC1E 7HT.
DEPARTMENT OF MEDICAL
PROTOZOOLOGY

JUNIOR MEDICAL LABORATORY SCIENTIFIC OFFICERS

are required to assist in research. Candidates should hold 'O' level passes in English, Maths, Chemistry and Biology; but preference will be given to those in possession of 'A' level Chemistry and Biology, or ONC in Biological Sciences. Salary, depending on age and qualifications, in the range £2169-£3015+£354 London Weighting. Applications, consisting of full education and career details and naming two referees, should be sent to **Secretary (A1)** at the School.

POSTDOCTORAL ORGANIC CHEMIST

Miles Laboratories Ltd are an international pharmaceutical company based in an attractive part of South Buckinghamshire.

We are currently seeking a PhD level Organic Chemist to join a small synthetic team engaged in research into allergic diseases. Candidates should have two to three years postdoctoral experience, be capable of supervising graduate chemists, and will be expected to make a significant contribution to the Department's scientific programme. Preferred age 26-30.

In return we offer excellent conditions of employment, four weeks holidays, subsidised staff restaurant, free life and private health insurance, contributory pension scheme, flexible working hours.

For an application form please write or ring my secretary on Farnham Common 2151: Mrs Nancy Morgans, Personnel Manager, Miles Laboratories Limited, Stoke Court, Stoke Poges, Slough.

UNIVERSITY OF ALBERTA, CANADA Department of Electrical Engineering

Applications are invited for a

RESEARCH ASSOCIATE

position in the plasma physics group at the University of Alberta. The research will involve the analytical and numerical modelling of CO₂ laser-plasma interactions. Salary will depend on experience, with a minimum of approximately \$20,000 per annum. Applications, including a curriculum vitae and the names of three referees should be sent to:

Dr C. E. Capjack, Department of Electrical Engineering, University of Alberta, Edmonton, Alberta, Canada T6G 2G7.

UNIVERSITY OF DUNDEE DEPARTMENT OF BIOLOGICAL SCIENCES

Applications are invited for two

LECTURESHIPS

in Microbiology in the above Department. No field of interest is excluded but it is hoped that one post will be filled by someone with an interest in microbial/molecular genetics.

The posts are permanent and superannuable under USS. Salary scale (under review) £3883 to £7754 with entry at points appropriate to the ages, qualifications and experience of the successful candidates.

Applications (six copies, overseas applicants one copy) quoting Reference EST/32/79Y and naming three referees should be lodged as soon as possible with The Secretary, The University, Dundee DD1 4HN, from whom further particulars are available.

CAMBRIDGESHIRE COLLEGE OF ARTS AND TECHNOLOGY

SENIOR ASSISTANT LIBRARIAN (SCIENCE)

Applications are invited for the post of Science Librarian in this large college. Candidates should be Chartered Librarians, possess a degree in an appropriate subject and have had sufficient relevant experience (preferably in an academic library) to enable them to offer an active library and information service to students and staff.

Salary and conditions of service within NJC AP3 grade £3732-£4146 per annum.

Details and forms from Librarian/Tutor, CCAT, Cambridge CB1 2AJ (Tel: (0223) 63271) to whom completed applications should be returned by 31 March, 1979.

BLOOD GROUP REFERENCE LABORATORY

Scientific Officer

A graduate is required to assist Dr C. M. Giles in reference work related to blood transfusion. This laboratory is recognised by the World Health Organisation as a Collaborating Laboratory for Reference and Research in Blood Grouping and many varied problems are investigated. Opportunities are available for study for a higher degree. Experience in the field of blood transfusion desirable.

Applications in writing, with curriculum vitae to Miss K. Lomas, Blood Group Reference Laboratory, Gatliff Road, off Ebury Bridge Road, London SW1W 8QJ.

UNIVERSITY OF LEICESTER LECTURESHIP IN BIOCHEMISTRY

Applications are invited for a Lectureship in the Department of Biochemistry. It is likely that preference will be given to candidates with a strong background and current interest in chemical and physical aspects of Biochemistry. Excellent research facilities are available. Candidates should be prepared to take up their duties from 1 October, 1979.

Salary according to qualifications and experience on the scale £3883-£7754 (under review) with superannuation benefits.

Further particulars from the Registrar, University of Leicester, to whom applications on the form provided should be sent by 27 April, 1979.

BIRKBECK COLLEGE

(University of London)

CHEMISTRY TECHNICIANS (GRADES 2B-4)

Applications are invited from suitably qualified and experienced persons for two posts of Technician in the Department of Chemistry. Appointment may be made in Grades 2B, 3 or 4 according to qualifications and experience. Salary scales under review. Apply with full curriculum vitae to Administrative Assistant (NS), Birkbeck College, Malet Street, London WC1E 7HX or telephone 01-580 6622, ext 271 for application form.

GRADUATE OR POSTDOCTORAL RESEARCH ASSISTANT

required for 1½ years in the Department of Microbiology for an MRC research project on cytomegalovirus immunovirology. Laboratory experience in virology essential.

Applications, with full curriculum vitae and the names of two referees, to the Secretary, Guy's Hospital Medical School, London Bridge SE1 9RT, quoting reference MC2.

YOUNG GRADUATE CHEMIST

for Process Improvement

We are part of an expanding, forward-looking, research-based, international organisation, in the Pharmaceutical and Fine Chemicals industry.

At our manufacturing plant on our 40-acre site at Sandwich in Kent, we have an additional vacancy in our expanded Chemical Process Improvement Laboratory which supports our Basic Production operations.

We are looking for a young graduate Chemist of either sex aged 25 or under with a good honours degree or G.R.I.C., who will join the team carrying out laboratory and plant work associated with trouble-shooting and process improvement in the organic and associated production departments. The work includes computer aided statistical evaluation.

This is a job for a person who enjoys bench work, but at the same time wishes to be involved in production activity. In this way career options can be kept open leading either to Laboratory or Production Management.

We offer a negotiable salary with annual increments and a performance-related bonus. Additional benefits include productivity, pension, death benefit, accident and sickness schemes. Where possible we operate flexible working hours.

We have an active Sports and Social Club with 12 acres of playing fields. Its facilities are well-supported by the 1400 employees on site, of whom some 250 are graduates.

Pfizer

We can also offer considerable financial assistance, where necessary, towards the cost of moving to this pleasant area close to the sea.

Applications, giving relevant details, should be sent to J. E. T. Haile, Personnel Department, Pfizer Limited, Sandwich, Kent.

THE UNIVERSITY OF LANCASTER DEPARTMENT OF PHYSICS

RESEARCH ASSOCIATE

Applications are invited for the post of postdoctoral RESEARCH ASSOCIATE in the Low Temperature Physics group. The post is financed by SRC for three years on the RA 1A scale (£3883-£6555, under review). The research associate will work with Drs Pickett and Guénault on experiments below 1mK on superfluid helium-3. A nuclear demagnetisation refrigerator constructed for this research programme is now nearing completion.

Further particulars may be obtained (quoting reference L123/C) from the Establishment Officer, University House, Bailrigg, Lancaster LA1 4YW, to whom applications (5 copies) naming two referees, should be sent not later than 30 March, 1979.

Editorial Assistant

The science editor of the leading weekly medical newspaper, General Practitioner, needs a second editorial assistant to help with the expanding clinical section of the newspaper.

He/she will be a recent graduate in one of the biological sciences.

Duties will include commissioning and editing clinical articles. There will be some writing but experience is not essential.

Send full details to Jenny Bryan, Science Editor, General Practitioner, Haymarket Publishing, 15 Lower Regent Street, London W1.

CHESTER COLLEGE OF HIGHER EDUCATION

Applications are invited from well-qualified graduates for the following post available from 1 September, 1979.

LECTURER II/ SENIOR LECTURER IN SOCIAL BIOLOGY

A biologist with interests in demography and the social applications of Biology, to help with the teaching of a new BA course in Health and Community Studies, and existing BA/BEd courses in Biology.

Further details from The Principal, Chester College, Cheyney Road, Chester CH1 4BJ. Closing date for applications 31 March, 1979.

GAME CONSERVANCY NORTH OF ENGLAND GROUSE PROJECT

Applications are invited for a seven year post to investigate the comparative population ecology of red grouse. Starting salary approx. £4300. The start by October 1979, at first in Fordingbridge HQ and then Yorkshire. Candidates should have a PhD in population dynamics or quantitative ornithology and be willing to travel extensively in North of England. Clean driving licence essential; vehicle provided. Curriculum vitae with two referees by 2 April to Dr G. R. Potts, Director of Research, The Game Conservancy, Fordingbridge, Hampshire SP6 1EF.

LECTURES, MEETINGS AND COURSES

UNIVERSITY OF LONDON ROYAL POSTGRADUATE MEDICAL SCHOOL MSc DEGREE COURSE IN EXPERIMENTAL PATHOLOGY (TOXICOLOGY)

Applications are invited for the above one year, full-time course which is being offered from 3 October, 1979.

Applicants should possess a first degree in medicine, veterinary medicine or appropriate science subjects.

A limited number of MRC course studentships are available.

Further details and application forms are available from the

Assistant Secretary (Registrar), Royal Postgraduate Medical School, Hammer-smith Hospital, DuCane Road, London W12 0HS. (Tel: 743 2030 Ext. 263)

The closing date for applications is Thursday, 31 May, 1979.

UNIVERSITY OF BRISTOL

12 MONTHS MSc COURSES BY
ADVANCED STUDY AND RESEARCH
are offered in the following subjects:

Advanced Analytical Chemistry (Inorganic Chemistry)
Surface Chemistry and Colloids (Physical Chemistry)
The Physics of Materials (Physics)
Mathematical Logic and Foundations of Mathematics (Mathematics)
Fluid Mechanics (Mathematics)

All five courses qualify for a quota of SRC advanced course studentships. Further details of the individual courses may be obtained from the Head of the Department concerned, University of Bristol BS8 1TH.

Enquiries are also invited for details of opportunities for research leading to the degree of PhD.



**PLYMOUTH
POLYTECHNIC**

B.Sc. (HONS) BIOLOGICAL SCIENCES

First Year Studies

Biological Science
Physical Science
Quantitative Methods

Second Year Studies

Biochemistry
Physiology
Population Biology
Ecology OR Cell Biology

Third Year Options

Cell Biology
Ecological Resource-
Management
Physiology
Cellular Toxicology
Crop Protection
Fish Biology
Pollution Studies

Enquiries to: Dr. W. Barton,
Course Tutor Biological Sciences,
Plymouth Polytechnic.

Drake Circus, Plymouth, Devon. PL4 8AA



**PLYMOUTH
POLYTECHNIC**

B.Sc. (HONS) ENVIRONMENTAL SCIENCE

Compulsory Studies

Concepts of-
Environmental Science
Techniques of-
Environmental Science
Resource Studies

Second Year Options

Human Ecology
Environmental-
Chemistry
Environmental-
Geology

Third Year Options

Ecological Resource-
Management
Environmental-
Economics
Environmental-
Psychology
Food Resources
Geochemistry
Geotechnics

Marine Chemistry
Mineral Resources
Pollution Chemistry
Pollution Studies
Population Studies
Urban and Regional-
Planning
Water Resources

Enquiries to: Dr. P. O'Sullivan
Course Tutor Environmental Science,
Plymouth Polytechnic.

Drake Circus, Plymouth, Devon. PL4 8AA

UNIVERSITY OF BRISTOL

MSc. (Meat Science)

This course occupies one calendar year and leads to the degree of MSc (Meat Science) by examination and dissertation. Candidates should have either an honours degree in the biological sciences or a degree in veterinary science. Applicants with other qualifications, if combined with previous industrial research or experience, may also be considered.

The course provides a systematic programme of study at an advanced level covering the whole field of meat science. Instruction will be provided by the staffs of the University School of Veterinary Science and of the Agricultural Research Council Meat Research Institute, which are both situated on the University's estate at Langford, about 14 miles south of Bristol. Accommodation is available in halls of residence.

Starting with the production of meat animals, the course extends through the scientific bases of all the operations involved in the production of meat and meat products, and includes consideration of the economics of the industry and of its controlling legislation. The objectives of the course are to equip graduates to apply the principles of meat science within the industry, to operate effectively in posts with responsibility for its legislative control or to provide them with the foundation for a career in meat research.

For further particulars please apply to
The Registrar and Secretary,
(Ref. CYF),
University of Bristol,
Senate House, Bristol BS8 1TH

UNITED KINGDOM ATOMIC ENERGY
AUTHORITY

THE 16 CULHAM PLASMA PHYSICS SUMMER SCHOOL TO BE HELD AT CULHAM LABORATORY, ABINGDON, OXFORDSHIRE, UK 2-13 JULY, 1979

BASIC PLASMA PHYSICS

BASIC PLASMA THEORY
PLASMA WAVES
KINETIC THEORY
PLASMA STABILITY THEORY
PLASMA DIAGNOSTICS
TRANSPORT THEORY

MODERN DEVELOPMENTS AND APPLICATIONS

PLASMA HEATING
FUSION DEVICES
ANOMALOUS TRANSPORT
THEORY
DRIFT WAVES
LASER FUSION
LASER-PLASMA INTERACTION
THEORY
COMPUTATIONAL PLASMA
PHYSICS
ASTROPHYSICAL PLASMA

Applications are invited from
postgraduate research workers and final
year undergraduates.
Application forms and further
details available from:

The Summer School Office,
Culham Laboratory,
Abingdon, Oxfordshire
OX14 3DB, UK.

Closing date for applications:
May, 1 1979.

Culham
Laboratory

UNIVERSITY OF READING

APPLIED AND MODERN OPTICS

FULL OR PART TIME
MSc COURSE

This is a 1-year course for the MSc degree by examination. To provide in-service specialist training for those in industry, the course may also be taken on a part time basis over two years.

The course is open to graduates in physics, mathematics or engineering. Students with recognised equivalent qualifications may also be admitted.

Studentships are available for suitable applicants, and opportunities exist for Research leading to the PhD degree.

Further details may be obtained from **Professor H. H. Hopkins, FRs, Department of Physics, The University, Whiteknights, Reading RG6 2AF.**

SLAM

SIMULATION LANGUAGE FOR
MODELLING CONTINUOUS
PHYSICAL PROCESSES ON ICL
1900 SERIES COMPUTERS.

SHORT COURSE:
9-11 APRIL, 1979.

Contact: **Doug Clarke, Department of Mathematics, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL.**

Tel: 0234 750111 Extns. 457 or 320.

University of Stirling

TECHNOLOGICAL ECONOMICS:
STUDIES IN MANAGEMENT
AND RESOURCE UTILISATION

- one year MSc course for scientists and engineers.
 - interdisciplinary PhD research programmes.
- SRC/SSRC and TOPS awards available.

Details from: **Dr M. F. Culpin (NS)**
Dept. of
Management
Science and
Technology Studies,
The University,
STIRLING, Scotland



THE UNIVERSITY OF LEEDS

DEPARTMENT OF FUEL AND COMBUSTION SCIENCE

POSTGRADUATE OPPORTUNITIES

Opportunities for postgraduate work in the above Department are offered in:—

RESEARCH

Combustion of Gaseous, Liquid and Solid Fuels
Fuel Economy and Energy Conservation
Environmental Pollution Control
Fuel Processing and Production of Synthetic Fuels
Fire and Explosion Prevention
Alternative Energy Sources

M.Sc. COURSES

Combustion and Energy
Environmental Pollution Control

POSTGRADUATE DIPLOMA COURSES

Fuel and Energy Engineering
Fuel and Combustion Science

Details from **Professor A. Williams, Department of Fuel and Combustion Science, The University, Leeds LS2 9JT.**

UNIVERSITY COLLEGE LONDON

MSc in Ergonomics

(Human Factors in Work Design and Production)

A one-year full-time or two-year part-time intercollegiate course for graduates with relevant honours degrees (eg Engineering, Psychology, Physiology or Anatomy). The course includes study of human physiology and anatomy, experimental and occupational psychology, systems analysis and instrumentation. A practical project will be carried out in an industrial or other appropriate setting.

Enquiries to: **Dr H. G. Maule, Ergonomics Unit, University College London, Wates House, 22 Gordon Street, London WC1H 0QB. Tel. 01-387 4168.**

QUEEN MARY COLLEGE

University of London
Chemistry Department

Applications are invited for a
POSTDOCTORAL RESEARCH
FELLOWSHIP

for work with Professor R. Bonnett (in collaboration with St Mary's Hospital Medical School) on the development of tetrapyrrole photosensitisers. The project would suit an organic chemist with experience in heterocyclic synthesis, but an interest in biochemistry and photochemistry would be an advantage. Starting date as soon as possible. Salary in range £4559-£4858 per annum (under review, including London Allowance). Please apply by letter giving age, qualifications, experience and names of two referees to The Registrar (NS), Queen Mary College, Mile End Road, London E1 4NS.

BALLIOL COLLEGE
OXFORD OX1 3BJ
Oxford OX1 3BJJUNIOR RESEARCH
FELLOWSHIP IN CHEMISTRY

The College proposes, if a suitable candidate presents himself or herself, to elect a Junior Research Fellow in Chemistry for a period of three years as from 1 October, 1979. The Fellowship is open to men and women pursuing research in any branch of Chemistry, and the Fellow elected may, with his or her consent, be assigned some share in the tutorial work of the College (provided that the total teaching involved shall not exceed six hours per week). Candidates are normally required to be under the age of 30 on 1 January in the year of election (i.e. 1979). The stipend of a Junior Research Fellow is currently £3325 per annum with superannuation, but this is now under review. In addition, the Fellow will be assigned rooms in College free of charge, and be provided with free meals. If the Fellow is married, a housing allowance of £350 may be payable in lieu of rooms. Applications should reach the College Secretary, from whom further details may be obtained, not later than 10 April, 1979.

HOWE SENIOR RESEARCH
FELLOWSHIP

Applications are invited by the Council of the Royal Society for the Howe Senior Research Fellowship, established from the Mr and Mrs R. L. Howe Bequest for the promotion and encouragement of scientific research. On this occasion applications are restricted to those working in the fields of fundamental or applied biological science. The appointment will be tenable in any appropriate university department of research institution in the United Kingdom approved by the Council of the Royal Society. Candidates, who must be citizens of the United Kingdom or the Commonwealth, must supply the usual personal details and give two referees. Testimonials will not be considered. The subject of the proposed research, and where it would be done, together with the name of the head of the department, whose consent should first be obtained, must be stated.

The appointment, which will be subject to the Society's general regulations governing research appointments, will be tenable for five years from 1 October, 1979 (or another date to be arranged) and may be renewable for successive five-year periods until the end of the academic year in which the holder becomes 65. Applicants should preferably be under 45 on 1 October, 1979. The stipend scale will be £8031 x £252 to £8787 x £249 to £9036 per annum, and the point of entry will be determined by Council Superannuation benefits will be provided. Some provision for research expenses will be available.

Applications should be made on forms to be obtained from the Executive Secretary, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG, and returned by 30 April, 1979.

BOC Scholarships
at
Cranfield

BOC Limited awards scholarships for one year MSc courses at Cranfield Institute of Technology in the School of Production Studies, Department of Materials (Welding Technology) or the Centre for Transport Studies.

The value of each scholarship is approximately £3,500 pa to cover living expenses and accommodation, which is available on the Cranfield campus, at low cost, for both single and married students. College fees are also paid by BOC.

The establishment of these awards reflects the concern of BOC and Cranfield to increase the standard of engineers in British manufacturing industry. We invite applications from men and women who have good degrees in engineering or science and a minimum of 12 months previous industrial experience, either as part of a sandwich course or post-university.

The scholarships are awarded on a competitive basis and selection interviews will be held early in 1979 for entry to Cranfield in October 1979. The closing date for application is 31 March 1979. Please write for further details and an application form to:



Professor B. B. Hundy,
School of Production Studies,
Cranfield Institute of
Technology,
Cranfield,
Bedford MK43 0AL.

THE AUSTRALIAN NATIONAL UNIVERSITY

Research School of Physical Sciences

Department of Theoretical Physics

POSTDOCTORAL FELLOW/RESEARCH FELLOW/SENIOR RESEARCH FELLOW

Applications are invited for appointment as Postdoctoral Fellow, Research Fellow or Senior Research Fellow in the Department of Theoretical Physics, Research School of Physical Sciences (one appointment). The Department would prefer to make an appointment in the research areas of elementary particle physics or field theory, but applications from theoretical physicists with research interests in other areas will be considered. The Department's main current interests are in fundamental aspects of particles and fields, statistical mechanics, solid-state physics, plasma physics and nuclear physics. A substantial part of the work is related to the experimental interests of the Research School.

Closing date: 18 May, 1979.

Salaries will be in accordance with qualifications and experience within the range: Postdoctoral Fellow—a fixed point between \$A15 786 and \$A20 606 per annum; Research Fellow—\$A15 786 - \$A20 606 per annum; Senior Research Fellow—\$A22 049-\$A26 301 per annum. Current exchange rates: \$A1:56p:£US1.13.

Terms of appointment: Postdoctoral Fellow—between one year and two years; Research Fellow/Senior Research Fellow: three years in the first instance with the possibility of extension to five years.

Other conditions: Reasonable appointment expenses are paid. Superannuation benefits are available for applicants who are eligible to contribute. Assistance with housing is provided for an appointee from outside Canberra.

The University reserves the right not to make an appointment or to make an appointment by invitation at any time.

Prospective applicants should obtain further particulars from the Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF.

UNIVERSITY OF HULL

DEPARTMENT OF APPLIED PHYSICS/PHYSICS

Applications are invited for

THREE RESEARCH FELLOWSHIPS

which are immediately available, for a period of up to three years.

Department of Applied Physics I. A research fellow is required to measure the frequency characteristics of the current generation of pulsed CO₂ lasers and to devise ways of improving their frequency stability using techniques such as hybridisation and injection locking.

2. A research fellow is required to work on the use of tunable multi-atmosphere, molecular gas lasers for the remote sensing of trace gases in the atmosphere.

Department of Applied Physics/Physics. 3. A research fellow is required to investigate the use of ion implantation for fabricating fast, photovoltaic, infrared detectors in materials such as HgCdTe. These fellowships are suitable for graduates in Physics, Applied Physics or Electronic Engineering with at least three years research experience in relevant fields.

Salary: The starting point will be within the scale, £3883-£4382 per annum (under review).

Applications should give full details of education, qualifications and research experience, together with the names of two referees, and should be sent by 31 March 1979 to Dr E. L. Thomas, Department of Applied Physics, The University of Hull, Hull HU6 7RX from whom further details may be obtained.

UNIVERSITY OF SUSSEX

School of Molecular Sciences

RESEARCH FELLOWSHIPS

Applications are invited for two SRC postdoctoral research fellowships to investigate problems in chemiluminescence and bioluminescence, tenable for two years from 1 October, 1979. One post requires experience in physical organic chemistry and organic synthesis, and the other in biochemistry or natural product chemistry. Starting salary in the range £3883-£4382 per annum on the Research Fellow grade 1A scale (under review), with superannuation benefits.

Applications, with the names of two referees, as soon as possible to: Dr F. McCapra, School of Molecular Sciences, University of Sussex, Falmer, Brighton BN1 9QJ, from whom further particulars can be obtained.

STUDENTSHPIS

SCOTTISH INSTITUTE OF AGRICULTURAL ENGINEERING POSTGRADUATE STUDENTSHIP

From October 1979

Applications are invited for an ARC Postgraduate Studentship tenable at the Scottish Institute of Agricultural Engineering, for work on the prediction and measurement of compaction under wheels and tracks of agricultural vehicles and the study of techniques for its reduction in practical crop production. The Institute is located at Bush Estate near Penicuik, to the south of Edinburgh.

Candidates must be British Subjects normally resident in the United Kingdom and should have a first or upper second class honours degree in Engineering, Agriculture or Science. Applications will be considered from those about to graduate but any award made will be conditional on the attainment of the required standard. Candidates should normally be under 27 years of age on 1 October 1979, but older candidates may be considered.

The award, which is under review, comprises a tax-free maintenance allowance according to circumstances, (£1610 p.a. for a single person living in rented accommodation) approved University Fees, some travelling expenses and dependent allowances where appropriate.

Full particulars obtainable from the Secretary, S.I.A.E., Bush Estate, Penicuik, Midlothian, EH26 0PH. Closing date for applications 9 April 1979.

UNIVERSITY OF BATH

School of Materials Science

RESEARCH STUDENTSHIPS IN MATERIALS SCIENCE AT BATH

Graduates and prospective graduates in Materials Science, Metallurgy, Chemistry, Physics, Engineering and related disciplines are invited to apply for SRC and other post-graduate studentships to study for MSc and PhD degrees. Grants and conditions are as for SRC studentships but with supplementation of up to £500 pa for certain CASE studentships. Enquiries for post-doctoral studies are also invited.

Research groups are active in the following fields:

- Acoustic Studies of Materials
- Biomedical Materials
- Carbons and Graphites
- Ceramics
- Composite Materials
- Corrosion and Oxidation of Metals
- Electron Optics
- Fracture Mechanics
- Surface Properties and Coatings

Write to:

Dr B. McEnaney, School of Materials Science, University of Bath, Claverton Down, Bath BA2 7AY. Tel: (0225) 61244 Ext. 432/448.

THE NATURAL ENVIRONMENT RESEARCH COUNCIL

RESEARCH STUDENTSHIPS : 1979

The Natural Environment Research Council is offering up to 294 research studentships for postgraduate training in scientific aspects of the natural environment. There are three main types of award.

(i) University or polytechnic based studentships

(i) **CASE studentships** Some of the awards, known as Co-operative Awards in the Sciences of the Environment (CASE studentships), are based at universities or polytechnics. Each is linked with an industrial or other non-academic institution which will cooperate in providing research training.

(iii) **Institute-based studentships** A smaller number of awards are tenable at Government-funded research institutes. In all cases a university or polytechnic link allows for joint supervision and higher degree registration.

Many of these studentships provide an appropriate form of training for graduates with a first degree in the environmental sciences such as geology, physical geography and the biological sciences; others are more suitable for graduates in areas such as engineering, mathematics, physics and chemistry whom NERC particularly wishes to attract into the environmental sciences. Studentships will normally begin on 1 October, 1979, and be tenable for up to three years. The basic annual grant for 1978/79 was £1610 plus approved fees. It is currently under review. Awards are made to students who hold good honours degrees, or the equivalent, or expect to obtain such qualifications in 1979. They should also have been resident in the United Kingdom for at least three years.

Already most of the studentships have been allocated to particular universities, polytechnics and research institutes. They can be taken up by students wishing to study in specified research areas under the supervision of named members of staff.

In addition there will be a small number of studentships for award later in the year thus:

(i) **A special competition** will be held for up to 5 studentships for prospective students of outstanding research merit who have already formulated their own research proposal. Applicants should submit a detailed account of their research proposal to NERC by 1 April, 1979, on application form RS1 (Comp) 1979.

(ii) **An appeals competition** will be held during August in response to applications made through heads of the departments where students wish to study. The limited number of studentships then available will not be restricted to departments or research areas to which awards have already been allocated and prospective students may wish to make enquiries to university or polytechnic departments about research training possibilities.

Full details of the location of awards already allocated and the research areas within which they may be held, and forms RS1 (Comp) 1979 are obtainable from the **University Support Section, Natural Environment Research Council, Polaris House, North Star Avenue, Swindon SN2 1EU, telephone (0793) 40101.**

DEPARTMENT OF METALLURGY AND SCIENCE OF MATERIALS

UNIVERSITY OF OXFORD

C.A.S.E. STUDENTSHIPS

Applications are invited from graduates (or students expecting to graduate this year) with a good Honours Degree or an MSc in Materials Science, Metallurgy, Physics, Chemistry, Engineering, etc.

Studentships available

- The generation of stresses during the oxidation of metals
- Stress corrosion cracking in aluminium alloys
- Studies of reactions between Portland cement and water
- Application of STEM to catalysis

Studentships pending

- Precipitation and segregation effects in steels
- SEM & TEM studies of dislocations and other defects in Indium phosphide
- STEM microanalysis of particles and segregation in steels
- Effect of elevated temperature on the strength of ceramics
- Stress corrosion cracking of pipeline steels
- Flash rusting of steel with water-base paints
- Structure and properties of magnet materials based on Mn-Al
- Electron-sputtering studies of pure metals
- Anomalous annealing effects in electron irradiation

Applications should be made as soon as possible, giving a brief curriculum vitae and the names and addresses of two referees to the **Administrator, Department of Metallurgy and Science of Materials, University of Oxford, Parks Road, Oxford OX1 3PH.**

University of Bath SCIENCE STUDIES CENTRE STUDENTSHIPS

Applications are invited from graduates with good honours degrees in sociology, or a branch of the natural sciences, for research leading to the degrees of MSc or PhD. The following areas of research are suggested:

1. Sociology of scientific knowledge
 2. Contemporary controversies/developments in science
 3. Scientific controversies related to the environment
 4. Post-industrial society
 5. Environment and politics
 6. Technology and values
 7. Technology, industry and work.
- Some studentships are available. For further details of the research programme of the Centre and areas of interest, please write to:

**Administrative Assistant,
School of Humanities and
Social Sciences,
University of Bath,
Bath BA2 7AY**

UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF PURE AND APPLIED CHEMISTRY

RESEARCH IN ORGANIC CHEMISTRY

Applications are invited for the following research post in biologically oriented organic chemistry available in October, 1979.

Potential Chemotherapeutic Agents based upon Latent Irreversible Inhibitors of Dehydrogenases.

SRC CASE Studentship in collaboration with Wellcome Research Laboratories.

Applications with names and addresses of two referees should be submitted to **Dr C. J. Suckling, Department of Pure and Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow G1 1XL**, from whom further information may be obtained.

UMIST

Corrosion and Protection Centre Research in Corrosion Science

Applications are invited for a

RESEARCH STUDENTSHIP

to study the effects of ion implantation on the aqueous corrosion behaviour of, and film formation on, magnesium and its alloys. The work will involve the use of advanced electrochemical and electro-optical techniques. Applicants should have a good honours degree in metallurgy, materials science or chemistry.

All applications and enquiries should be addressed to **Professor G. C. Wood, Corrosion and Protection Centre, U.M.I.S.T., P.O. Box 88, Manchester M60 1QD**, quoting ref. VA/RP/AJ.

THE OPEN UNIVERSITY

ENERGY RESEARCH GROUP STUDENTSHIPS

The Energy Research Group at the Open University invites applications from recent or prospective graduates for full-time studentships tenable from 1 October, 1979, at Milton Keynes. The Energy Research Group is an interdisciplinary research unit, the principal present research interests being energy policy, energy systems modelling, transport fuels, energy in housing, alternative energy futures, and heat pump research. It is anticipated that three research studentships will be offered in the above areas, according to the interests and abilities of prospective applicants.

Further particulars and application forms are available from:

Higher Degree Office, The Open University, P.O. Box 49, Milton Keynes MK7 6AD. Please quote reference (CD/2).

The closing date for receipt of applications is 2 April, 1979.

UNIVERSITY OF NOTTINGHAM AND TROPICAL PRODUCTS INSTITUTE

RESEARCH STUDENTSHIP: SILAGE FROM TROPICAL FISH

Applications are invited from those holding at least a 2(i) Honours BSc degree or an MSc degree, in biochemistry, chemistry, animal science or food science, for a TPI Research Studentship tenable at the University of Nottingham.

The successful applicant will be based in the Food Science Laboratories of the Department of Applied Biochemistry and Nutrition, Sutton Bonington, and will be required to work full-time on a programme for the development and nutritional testing of silage from tropical fish and register for a research degree of the University of Nottingham. During the tenure of the studentship the appointee, who will be selected following an interview, will probably be required to spend a period of time overseas. Those interested should write, in the first instance to: The Secretary, University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, Leics. LE12 5RD. Tel: Kegworth 2386.

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Atomic Physics

Applications are invited for an **SRC RESEARCH STUDENTSHIP**

for experiments on the Photoionization of Atomic Ions by UC radiation. The research programme in this entirely new field will utilize the new Synchrotron storage ring at the Daresbury Laboratory. Preliminary experiments will be conducted at Newcastle. This is an excellent opportunity for a gifted experimentalist with a first or upper second class honours degree to proceed to a PhD in Physics.

For further details, write to **Professor K. Dolder, Department of Atomic Physics, The University, Newcastle upon Tyne NE1 7RU.**

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SPECTROPHOTOMETERS

We require two spectrophotometers (IR and UV/VIS) for routine use in a small laboratory.

Please send brief details, name and telephone number to Box No. D368.

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exp: phytopl. (culturing, phys., prim. prod.), pollution—toxic. (oil, cooling water), opt. ocean., POC-DOC-transport modelling, ref: available; worked in North Sea, Caribbean, Dutch Est.; looks for job in aquatic ecology. Please contact: **Drs J. El, DIHO, Vierstr. 28, Yerseke, Holland.**

MEDICAL GRADUATE

with experience of teaching and army service needs overseas appointment of Demonstrator in Anatomy/Medical Officer. D369.

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Ariadne

■ Some months ago, a London daily newspaper carried several reports of a marvellous robot from the US. The thing, allegedly, could do such social jobs as serve drinks and it had impeccable manners, courteously asking how its admirers were in health and, for all I know, doffing its hat. It was taken, I remember, to a stately home, where it behaved, as far as could be ascertained, rather like a butler from a Hollywood film, deferential but with a hint of familiarity, exchanging chit-chat.

My first reaction to this amazing machine, which was, if the claims were true, a giant step for robotkind, can be expressed in one word. Rubbish. Having reached this point, I waited for the contumely and scepticism to fall. Nothing happened. There was not a word of doubt, not even a derisive mention in *New Scientist*. After a time, which included a visit to Buckingham Palace surrounded by a goggling throng, the robot, whose name was Quasar, returned to the States, hobnobbing with air hostesses en route.

Word now reaches me that a robot called Sam Strugglegear (possibly an alias, as it is made by Quasar Industries) is having a hard time from sharp-eyed observers of Stanford University's Artificial Intelligence Laboratory. They have distributed a memorandum that says they found that whenever S. Strugglegear appeared, there was a man close by muttering into his hand when the robot was talking and wagging his hand in an airline bag when it moved. Charitably, the Stanford team calls Strugglegear a reasonably good parlour trick and little, if anything, to do with artificial intelligence.

I was wrong, too. I thought it would turn out to be a dwarf of culture, charm and immaculate address, locked into the metal hull of the robot. There was a chess-playing dwarf who took on any player in Europe in the 18th century from inside a robot called "the Turk".

■ Watching the manoeuvres of a man in a pub the other day brought on another fit of the "Why can't they invent?" melancholia. He was trying to eat one of those long sausages that pubs describe as "jumbo" or "king size" because, I assume, "big" is too short and adult a word. He was trying, as we all have tried from time to time, to eat it one-handed. It had been taken from a heated cupboard, where the sausages, like stranded, sea-going yachts, lay on their sides with cocktail masts horizontal.

The cocktail stick was central. The sausage revolved on it. The embarrassed potential biter tried a quick snap. The sausage spun and hit him a tiny, greasy blow on the other side of his mouth. Another snap and the sausage reversed the action. By making mambling movements of his lips, the maddened luncher finally got the sausage still enough to take a bite. The cocktail stick went up one nostril.

It's no good trying two cocktail sticks or a fork. Both are good solutions to the problem if you have two hands free; out of the question if you are holding a beer, a plate and wet change in one. What's needed is a paper socket, like the cup of an acorn, fixed on one end of the sausage. One-handed eating would then become a delight to the eye, a comfort and satisfaction to the eater and the recalcitrant sausage one with the ages.

■ California State University has an idea in teaching biology that will cause a few heads to nod in confirmation of received ideas about the US. It asks students to write TV or radio commercials on parts of the human cell. Ask your friendly neighbourhood mitochondrion store for a free trial. Cytoplasms now contain the secret ingredient. Sale of organelles for two weeks only. Free vacuole with every three ribosomes.

It's an idea that could be applied to parts of the body, too. They would really test the power of salesmanship in obtaining an order, for instance, for a gross of vermiform appendixes. The reverse might be interesting, looking at the human body through the eyes of a Ralph Nader. There would, I think, be quite a scope for criticism of the liver as a chemical engineering plant and of such joints as the knee, continually failing because of breakdown of its lubrication system.

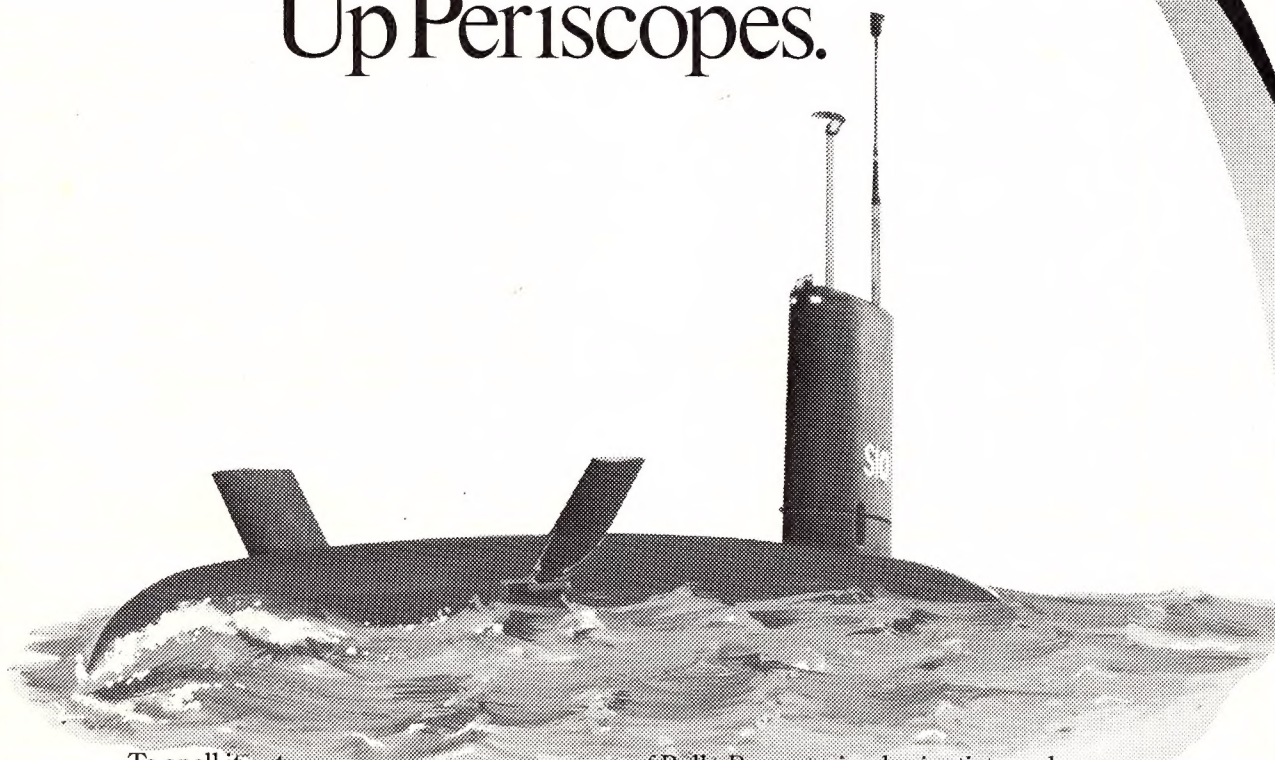
■ Pins-and-needles, observes my repulsive friend Daedalus, arises when nerves from the hand are compressed where they pass the elbow, say by awkward posture. This triggers them, and the brain thinks the sensation has come from the hand. Seeking to refine the principle, Daedalus is inventing a piezo-electric bracelet. Its ring of ultrasonic transducers launches a pulse into the arm on command. If all the transducers

fired together, the resulting ultrasonic compression-wave would converge to produce a transient shock-pulse in the centre of the arm. But the speed of sound in human tissue is only about 1500 metres a second; so judicious microsecond delays, introduced between transducers on opposite sides, could make the shock converge on any chosen point inside the arm—such as a single selected nerve. The pins-and-needles principle would then fire that nerve.

At first Daedalus saw his bracelet purely as a research tool for exploring the nervous system: injecting pulses into specific nerves and seeing what sensations they created or what muscles they twitched. But he then realised that the principle is reversible. As a nerve conducts, the opposite charges on its centre and outside cancel. The removal of their attraction must expand the nerve momentarily, launching a weak ultrasonic pulse radially outwards. This would reach a ring of piezoelectric detectors on the skin with exactly the same time-delays as those needed to fire that nerve by inward pulse-propagation. So Daedalus's "Twingemaster" medical sensation-transfer machine has a "detector" bracelet on the patient, and a "repeater" in the same place on the doctor, with corresponding transducers directly coupled. Thus the varyingly-delayed signals from a nerve in the patient launch a pulse in the doctor which converge on the corresponding nerve in him. So at last he can feel his patient's twinges, copy his muscular tremors, and diagnose by direct transferred experience! Giving an injection, feeling for a grumbling appendix, resetting a dislocation, he will feel directly what he's doing, and automatically avoid needless pain. Besides, an annoyed patient could, by suddenly hitting himself in the face, cause the unwary doctor to do likewise!



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